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GENERAL REVIEW OF THE TRAWL FISHERY AND THE DEMERSAL FISH STOCKS OF THE SOUTH CHINA SEA

by

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PREPARATION OF THIS PAPER

This paper is a revised version of contribution IPFC/72/19 submitted to the 15th Session of the Indo-Pacific Fisheries Council (IPFC) in Wellington, New Zealand, 18-27 October 1972. In view of its importance and general interest the Council recommended that FAO should publish it.

This paper summarises the present state of knowledge of the demersal fish resources of the South China Sea and their potentials. It constitutes a contribution in preparation for the relevant section of the FAO World Appraisal of Fishery Resources.

The World Appraisal of Fishery Resources (WAFR) is a continuing programme of FAO, maintained by the Fishery Resources Division in close cooperation with national and regional fishery bodies and experts for a comprehensive and up-dated review and dissemination of information on the state of the world's marine and inland living resources and their potentials. Under the guidance of the FAO Advisory Committee on Marine Resources Research (ACMRR), WAFR developed out of preparations for the fishery sections of the Perspective Study of World Agricultural Development (PSWAD), previously known as the Indicative World Plan for Agricultural Development (IWP). Major outputs of this programme have so far been the review on "The Fish Resources of the Ocean" (FAO Fisheries Technical Paper No. 97) which has been published under the same title as a book by Fishing News (Books) Ltd., and the "Atlas of the Living Resources of the Seas" published by FAO in 1972.

WAFR is being progressively developed to provide a regular service to member governments and other utilisers and to become one sectorial component of the "World Earth Watch" system recommended by the UN Conference on the Human Environment in 1972.

The paper was prepared by Dr. S. Shindo while he was employed by FAO as a Consultant at FAO Headquarters in Rome and visiting some places in the South China Sea area in order to obtain additional material. The views expressed in this paper are those of the author and not necessarily those of FAO.

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ABSTRACT

This report reviews, in its first part, the past and present situation of the demersal fisheries in the South China Sea, with special reference to trawl fisheries. Detailed information on the fisheries on the Mainland Shelf (from Taiwan to Hainan Islands), and recent information on the fisheries on the Sunda Shelf are given.

The second part of the report is devoted to an appraisal of the demersal fish stocks in the South China Sea in comparison with those in the East China Sea and the Yellow Sea.

The demersal fish stocks on the Mainland Shelf have been exploited intensively. A further increase in the fishing intensity in this area should be discouraged.

On the Sunda Shelf, with the exception of the Gulf of Thailand, the demersal fish stocks are relatively underutilized and further expansion of the fishery may be possible. However, in the Gulf of Thailand, the stocks are now overutilized and management measures to protect the demersal fish resource in the Gulf should be initiated without delay.

Recommendations for future action are given to promote the rational utilisation of the demersal fish resources in the South China Sea.

1. INTRODUCTION

This report presents the appraisal of the prevailing state of the demersal fish stocks and fisheries in the South China Sea in compliance with the recommendations adopted by the Thirteenth (1968) and the Fourteenth (1970) Sessions of the Indo-Pacific Fisheries Council (IPFC).

In the past, several reports on the biology of certain demersal fish species or various fisheries in certain parts of the South China Sea and on the results of exploratory fishing surveys and experimental fishing in particular areas have been published by national laboratories or governmental agencies concerned in the region. However, only a few papers attempt to give a wider scope covering the status of the fish stocks and fisheries in these waters. Shomura (1971) presents a review of the fisheries and a preliminary assessment of the demersal fish stocks in the western central Pacific waters, including the South China Sea and adjacent waters. His estimates are based on the available data of the fisheries up to 1965. The state of the demersal fish resources on the Sunda Shelf up to 1966 is also summarised by Menasveta (1968).

At the International Seminar on Possibilities and Problems of Fisheries Development in Southeast Asia, organized by the German Foundation for the Developing Countries in cooperation with the German Federal Research Board for Fisheries and FAO (Berlin, 10-30 September 1968), the possibilities and problems in connexion with further trawl fishery development in the South China Sea and contiguous waters were discussed (Tiews, 1969).

The IPFC Working Party on Trawling was reactivated by the Fourteenth Session of the Council (1970) to undertake the review of the current situation of the trawl fisheries and the state of the demersal fish stocks in the South China Sea. This report, submitted to that Working Party is based, in part, on unpublished recent material from the author and from other sources mentioned in the acknowledgement.

On the basis of the available information, the current situation of the trawl fisheries and the demersal fish stocks in the area is appraised, and recommendations on the possibilities for further development and problems confronting such development are made.

2. AREA STUDIED

2.1 Area coverage and depth

The South China Sea, referred to in Chinese as Nan Hai, is the contiguous water to the Pacific Ocean, bordered in the west by the Asian Continent, the southern limit of the Gulf of Thailand, the east coast of the Malay Peninsula, and in the south by the islands of Sumatra and Borneo. According to the International Hydrographic Bureau, the northern boundary is the line drawn from the northern tip of Taiwan, westward to the coast of Fukien of Mainland China, the southern boundary at about lat. 3°00'S between Sumatra and Borneo. It embraces a total area of approximately 3.4×10^6 km^2. A deep basin, called the China Sea Basin with an abyssal plain having a mean depth of 4 300 metres, is located in the north central part of the South China Sea. As shown in Figure 1, several large shoals studded by coral reefs occur within the basin, such as Reed, Tisard, Nan-sa Banks in the south, and Paracel Island, Macclesfield Banks in the north. On the west side of Palawan and especially Luzon, as well as along the eastern coast of South Vietnam, the continental slope is rather steep and the continental shelves narrow.

Two wide continental shelves are located in the marginal area of the South China Sea, bordering the deep basin mentioned above: the Mainland Shelf in the north and the Sunda Shelf in the south.

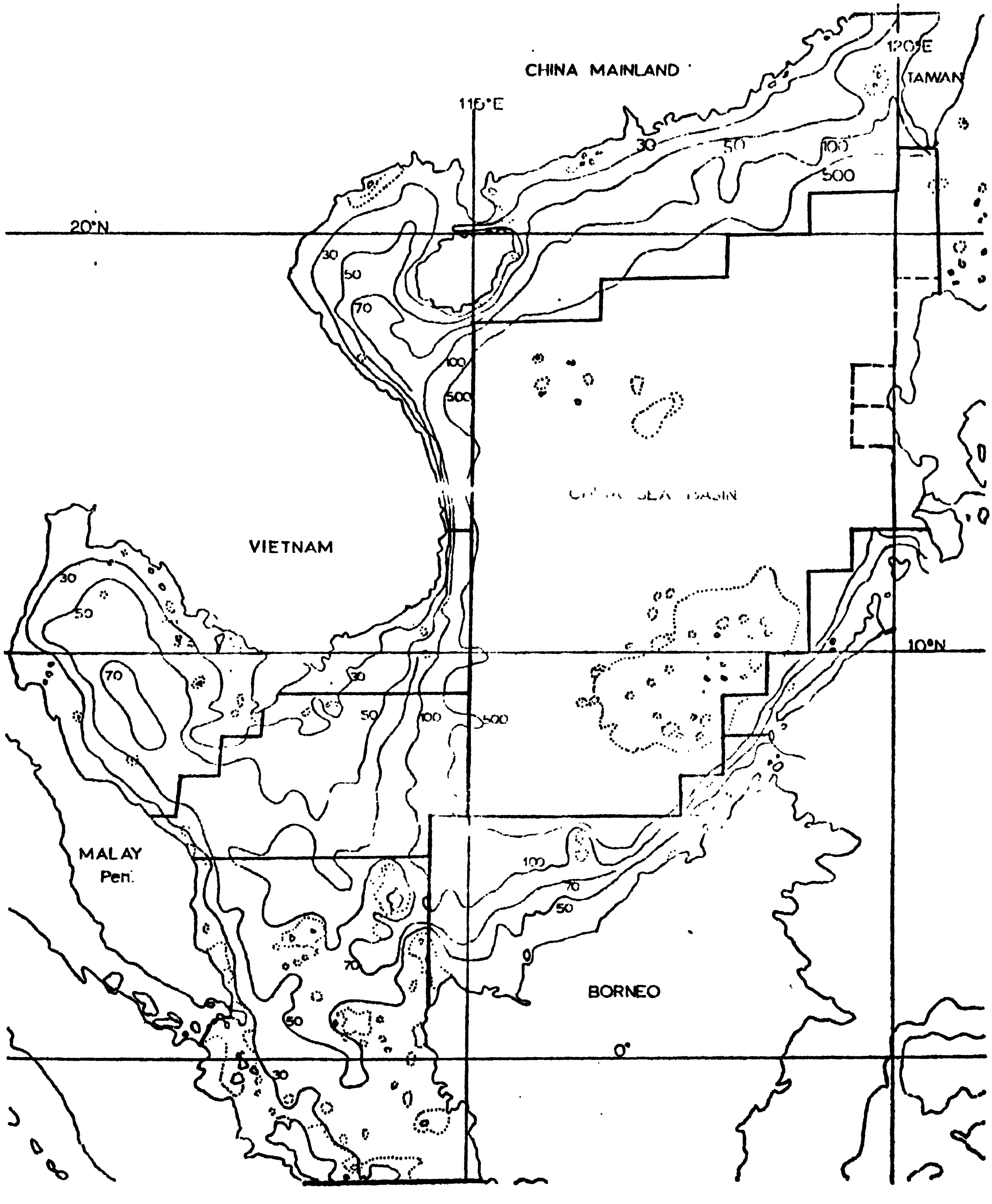

Figure 1. The South China Sea showing depth contours down to 500 metres (source: preliminary chart prepared by Res. Dept. SEAFDEC)

Along the northwest side of the basin, the continental shelf extends about 250 to 300 km offshore: the Taiwan Strait as well as the Gulf of Tonkin are included here. The two large islands of Taiwan and Hainan are situated on this shelf. The Gulf of Tonkin gradually deepens toward its centre with a maximum depth of about 70 metres. To the south off the east coast of South Vietnam, the shelf becomes narrow and connects with the Sunda Shelf.

The Sunda Shelf, formally called the Southeast Asiatic Bank, being one of the largest continental shelves in the world, is surrounded by the Asian Continent and the three large islands of Sumatra, Borneo and Java, the southern part of the South China Sea, the Gulf of Thailand, Gasper and Karimata Straits.

The Sunda Shelf is relatively shallow with depths of mainly 40 to 100 metres in the southern part of the South China Sea. The Gulf of Thailand is also shallow, only approximately 80 metres in its deepest centre. Located in the centro-southern part of the Sunda Shelf are some islands, such as Anambas and Natoena, and many shoals. These islands and shoals are covered by large coral reefs. To the south, between Sumatra and Borneo, the shelf becomes shallower with depths of 20 to 40 metres.

2.2 Division by subareas and squares

Considering both natural factors, such as locality, depth, bottom composition, etc., and fisheries, the overall area of the South China Sea can be divided into 11 subareas. The Mainland Shelf is divided into three subareas as follows: northern Mainland Shelf from Taiwan Strait to nearly the middle of Hainan Island, the Gulf of Tonkin, and the southern Mainland Shelf from south of Hainan Island to the most narrow shelf off Vietnam at lat. 13°00'N. The Sunda Shelf is divided into six subareas as follows: the northern Sunda Shelf from the most narrow shelf off Vietnam at 13°00'N to the waters off the coast of southeastern Vietnam, the central Sunda Shelf, the Gulf of Thailand, the southern Sunda Shelf with Anambas and Natoena Islands, the eastern Sunda Shelf off the northwestern coast of Borneo, and the Gasper-Karimata Straits south of the Equator. Another two subareas are the Palawan-Luzon region with a very narrow shelf off the west coast of these islands, and the China Sea Basin.

Figure 2 is a map showing the breakdown into these subareas and into a grid of 1° squares which are numbered in accordance with the Marsden Square system. In Table 1 an estimation is presented for the size of the various sea areas less than 500 metres deep. Each subarea includes squares with waters shallower than 500 metres. Modern trawlers are operating in the waters not only on the continental shelves of less than 200 metres but also in deeper waters on the continental slopes (more than 300 metres), sometimes 500 metres or more in depth. However, according to the recent results of deep sea exploratory trawling in the southern part of the East China Sea by R/V KAIYO MARU (2 540 GT, 3 800 HP) in 1967, few fishes of commercial importance were caught in waters of more than 500 metres depth (Shindo et al., 1971). During the same exploratory trawling survey on the Mainland Shelf of the South China Sea in 1971, only a few fishes of economic value were found in waters deeper than 350 metres (Aoyama et al., 1971). So far, there is little experience with trawling in the tropical deeper waters. In this report, only the areas with waters of less than 500 metres in depth will be considered in the assessment of the standing stocks of demersal fish in the South China Sea.

The sizes of the areas indicated in Table 1 are only approximate, particularly in those areas surrounding islands with narrow shelves. Shomura and Gulland have estimated the areas of shallow water of less than 200 metres in the South China Sea (cf. Shomura and Gulland, 1970; p. 131, Table I-1). Comparing their figures with those in Table 1, 280 000 km^2 was given by them for the waters from Formosa (Taiwan) Strait to the Chinese south coast, while 341 000 km^2 is estimated for these areas here; 200 000 km^2 for the Gulf of Tonkin (to 15°N) in their paper against 220 000 km^2 (sum of Gulf of Tonkin and southern Mainland Shelf); 305 000 km^2 for the Gulf of Thailand against 304 000 km^2; 970 000 km^2 for the South China Sea (from 15°N to the Equator) against 1 229 000 km^2 (sum of four subareas on Sunda Shelf). Shomura and Gulland calculated an overall size of 1 755 000 km^2 for the total area against

Table 1. Division of the South China Sea into subareas and estimated areas in km^2

	Subarea	Square numbers involved[1]	No. of squares	Area[2]	Conversion factor[4]	Area converted	Area in km^2
Mainland Shelf	Northern Mailand Shelf	(061) 70, 80–82, 90–95; (096) 20, 30, 40; (097) 00–07, 10–19, 23–29, 36–39, 48, 49	40	29.3	0.94	27.5	341 000
	Gulf of Tonkin	(062) 76, 77, 85–88, 95,99; (098) 06–09, 17–19	18	11.7	0.95	11.1	131 000
	Southern Mainland Shelf	(062) 39, 48, 49, 58, 59, 67–69, 78, 79, 89	11	7.5	0.96	7.2	89 000
Sunda Shelf	Northern Sunda Shelf	(026) 95–99; (062) 06–09, 18, 19, 29	12	7.1	0.98	7.0	87 000
	Central Sunda Shelf	(026) 52–58, 63–69, 74–79, 85–89	25	22.5	0.99	22.3	276 000
	Gulf of Thailand	(026) 61, 62, 70–73, 80–84, 90–94; (027) 99; (062) 00–04, 10–13, 20–22, 30; (063) 09, 19	32	25.2	0.98	24.5	304 000
	Southern Sunda Shelf	(026) 03–08, 14–18, 23–28, 33–38, 43–48	29	26.6	1.00	26.6	330 000
	Eastern Sunda Shelf	(025) 10, 20, 21, 30–33, 40–44, 50–55; (026) 19, 29, 39, 49, 59	26	18.7	1.00	18.7	232 000
Karimata-Gaspar Region		(324) 70, 80; (325) 75–79, 84–89, 93–99	19	12.2	1.00	12.2	151 000
Luzon-Palawan Region		(025) 86, 87, 97, 98; (060) 20, 30, 40, 60, 70, 80; (061) 08–09, 18, 19, 29, 59, 69	17	4.2	0.98	4.1	51 000

Table 1. Division of the South China Sea into subareas and estimated areas in km^2 (Continued)

	Square numbers involved 1/	No. of squares	Area 2/	Conversion factor 4/	Area converted	Area in km^2
Sub-total		229	-	-	161.2	1 992 000
China Sea Basin	(025) 60-64, 70-75, 80-85, 90-96; (060) 90; (061) 00-07, 10-17, 20-28, 30-39, 40-49, 50-58, 60-68, 71-79, 83-89, 96-99; (096) 00, 10; (097) 08,09	113	+12 3/	0.97	121.3	1 503 000
Total		342	-	-	282.5	3 495 000

1/ The figures in parentheses and underlined show the number of 10° squares in the Marsden System, the following figures that of the 1° squares.

2/ Area excluding lands and waters deeper than 500 m. Figures are counted in 1° square units.

3/ Sum of the areas having depths greater than 500 m which surround the China Sea Basin and which are excluded from the other ten subareas.

4/ The area of each 1° square becomes narrower with increasing distance from the Equator to the north. The conversion factors are the ratios of the average area of one square in each subarea and that of the standard square on the Equator, that is 12 388 km^2.

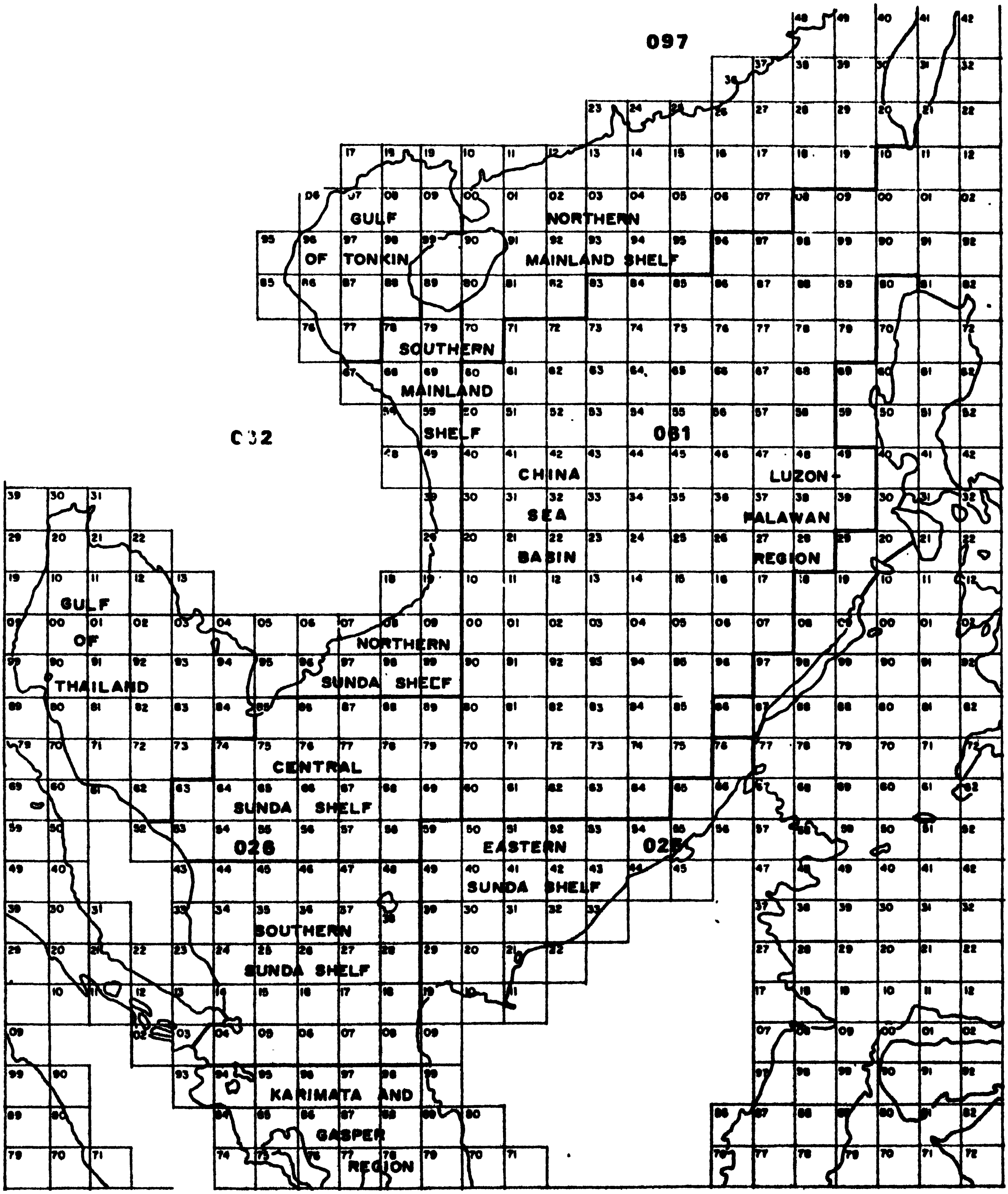

Figure 2. Subareas in the South China Sea and division into numerical squares

1 941 000 km^2 in the Table 1 of this report. Hence, the area estimated here is 1.11 times larger than that estimated by the previous authors. The difference may be due to different area coverage, since the former considered areas of less than 200 metres, while the present estimation is made for waters of less than 500 metres. According to LaFond (1966) the entire area of the South China Sea (including China Sea Basin) estimated by the International Hydrographic Bureau is 3.4 million km^2. This figure is only slightly different from the estimate of 3.49 million km^2 presented here.

It should be noted that the estimated total area of the South China Sea proper including the Gulf of Thailand as presented in this report is approximately 186 000 km^2 greater than the estimates given by Shomura (1970). This difference represents the waters between 200 metres and 500 metres depth.

3. THE PAST AND THE PRESENT SITUATIONS OF DEMERSAL FISHERIES IN THE SOUTH CHINA SEA

3.1 Fishing activities in the pre-second world war years

3.1.1 General situation

Demersal fishing in the South China Sea before the second world war was operated by all countries bordering these waters, employing several types of traditional demersal fishing boats and gear, such as single or pair sailing trawlers, longliners with sailing mothership accompanied by many small rafts, etc., especially in the coastal waters of the northern part of the South China Sea from Taiwan to Vietnam. These fishing operations are not described in this paper because of the shortage of detailed information.

In 1927, HAKUHO MARU (333 gross ton otter trawler), the fisheries inspection vessel of the Japanese Government, carried out experimental and exploratory fishing in the northern South China Sea. The survey revealed that the stocks of several species of sea breams and snappers which are of commercial value in Japan inhabited these waters, especially in the Gulf of Tonkin.

This information led to the introduction of modern otter trawl net fishing in these waters. The fishing activities of the pre-second world war Japanese trawler fleet in the South China Sea were well summarized by Bourgois (1950). More detailed information, based on original material, is given below.

In 1928 the Japan Trawling Co. sent a first commercial otter trawler (361 gross tons) to the Gulf of Tonkin; followed by three vessels of that company in 1929. Since then the number of large size Japanese otter trawlers operating in the Gulf increased year by year to a substantial level. The main fishing grounds of this trawler fleet were located within the Gulf. Fishing operations in the northern Mainland Shelf from Taiwan to Hong Kong were almost negligible.

Furthermore, in those days a fleet of smaller-sized otter trawlers based in Taiwan operated in the Taiwan Strait as well as in the waters near Taiwan Bank, i.e., the southwestern waters off the southernmost point of Taiwan. However, the main fishing grounds were located in the southwestern part of the East China Sea off the coast of Fukien Province of China. As far as the South China Sea is concerned, the activities of these smaller-sized trawlers were limited only to a small area in the northwest.

On the other hand, a Japanese pair trawler fleet operated in the waters between the Taiwan Strait and Taiwan Bank at that time. They were much interested in the results of exploratory fishing in the waters from Taiwan Bank to Hainan and in the Gulf of Tonkin during 1935-36, carried out by SHONAN MARU (680 HP), a research vessel of the Taiwan Fisheries Experimental Station. They began to spread their fishing area southward to the Mainland Shelf of the South China Sea. Since then, the fishing grounds expanded southwest-

ward to the waters off the south coast of Hainan. The fleet made a base port at Nha Trang in South Vietnam. The number of pair trawlers operated in the South China Sea since then increased rapidly.

The fishing grounds of these Japanese pair trawlers were limited legally to waters north of 15°N. The operation of pair trawlers in the Gulf of Tonkin, where fishing was conducted by large otter trawlers described above, was prohibited. In summary, the fishing activities of the pre-second world war Japanese trawlers may be divided into two categories: otter trawling in the Gulf of Tonkin and pair trawling in the offshore waters along the Mainland coast from Taiwan to Hong Kong and south of Hainan Island.

3.1.2 Otter trawling in the Gulf of Tonkin

After an exploratory trawling survey made by the fisheries inspection vessel of the Japanese Government, HAKUHO MARU, in 1927, a commercial trawler, KEINAN MARU (316 gross tons) visited the area in the following year. The number of Japanese trawlers operating in the Gulf of Tonkin between 1928 and 1938 is shown in Table 2.

Table 2. The number of Japanese otter trawlers operating in the Gulf of Tonkin before the second world war

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938 1/
No. of vessels	1	4	14	11	10	14	18	20	19	20	18
No. of hauls	?	?	?	4 237	4 212	8 488	7 449	12 492	11 298	9 610	5 035
Catch in metric tons	?	?	?	3 379	2 940	6 203	4 045	11 678	11 021	11 678	6 446
Catch per haul in kg	?	?	?	797	698	731	543	935	975	1 215	1 280

1/ Data after 1939 are not available because of the outbreak of the Sino-Japanese War

These otter trawlers until 1934 fished only in the southern half of the Gulf. After 1935 the fishing grounds were expanded into the northern half of the Gulf, north of 20°N, and this part became a main fishing ground for the Japanese trawlers.

Besides, a few trawlers sometimes operated in the offshore waters of Hong Kong, off the east and south coasts of Hainan Island, as well as off Sarawak, but their activities were very limited in these waters. The total operation from 1931 to 1938 amounted only to 1 865 hauls or less than 3 percent of the entire total of 62 749 hauls made by Japanese otter trawlers, including the trawling operations in the Gulf of Tonkin.

It can be said, therefore, that almost all of the activities of these trawlers were concentrated within the Gulf of Tonkin. These trawlers, however, did not operate all year round in the Gulf; the activities were restricted by the Government. Most of the vessels were based in Japan, but some of them were based in Taiwan or in Hong Kong for several years. The catches were mostly transported to Japan, except those from the Hong Kong base.

The gross tonnage of these trawlers varied from small-sized vessels to large-sized ones with an average of approximately 500 gross tons. The maximum annual total landings from the trawler fleet was about 12 000 metric tons in 1935 and 1937 when 12 vessels operated in the Gulf. The total catch gradually increased with some annual fluctuations up to around 1934, after which it increased rapidly to about 11 500 tons but dropped again in 1938. The average catch per haul seems to have decreased slowly till 1934. After 1935, it increased fairly continually to a high level of about twice the amount before that time, and still showed a tendency to increase. It appears that the main cause of the increased catch and c.p.u.e. was the expansion of the fishing grounds to the northern half of the Gulf where the stocks had been underutilized.

The Japanese otter trawlers operated in the Gulf of Tonkin for catching a species of sea bream, Argyrops cardinalis (Temminck and Schlegel), referred to in Japanese as "Chiko dai" as it resembles in shape and taste Evynnis japonicus ("Chi dai" in Japanese) which is one of the most economically important fish in the East China Sea. Therefore, many trawlers eagerly searched for this fish. Its share was two thirds of the total catch in weight. As Shibata (1940) pointed out, other species had been considered as incidental catches, and according to his analysis, the significant correlation between catch per haul and fishing effort could be seen only in the case of this fish.

After 1939, owing to the outbreak of the Sino-Japanese war, the fishing activities of these trawlers in both the Gulf of Tonkin and in the Strait of Taiwan declined steadily and stopped completely at the end of the war.

3.1.3 Pair trawling in the northern South China Sea

The Japanese pair trawl fishery in the pre-war years was concentrated mainly in the northern South China Sea, namely on the continental shelves from Taiwan Strait to the waters off Hong Kong and also in offshore waters of the south coast of Hainan Island. In 1924, motorized pair trawlers, for the first time, were introduced into Taiwan from Japan.

In the early period, these pair trawlers operated in the waters from the East China Sea through the Taiwan Strait and on the Taiwan Bank. The decline in the abundance of the yellow sea bream (Taius tumifrons), the main objective species, in these waters forced them to move southwestward into the South China Sea.

The expansion of the fishing grounds was encouraged by the promising results from the exploratory fishing survey made by R/V SHONAN MARU of the Taiwan Fisheries Research Station during 1935-36. The fishing areas were expanded to cover the whole Mainland Shelf and the offshore waters of Hainan Island. However, the size of the pair trawler fleet was not so large since the vessels were inferior in range compared with large otter trawlers. Therefore, it is thought that the main fishing grounds for these pair trawlers were concentrated in the waters of the Strait of Taiwan and Taiwan Bank.

Some pair trawlers based in Nha Trang of Vietnam also fished in the offshore waters between Hainan Island and the Vietnam coast. However, the number of these vessels was small, and details of their activities are not known because of the lack of adequate records.

The greater part of the catches from these pair trawlers was consumed within Taiwan itself. The catches from a few vessels operating in far distant waters, such as off Hong Kong and Hainan, were transported to Japan by two large freezing carriers.

The average gross tonnage of these Japanese pair trawlers was approximately 50 tons at the beginning of the fleet activities in the Gulf. In the following years it increased steadily, reaching 70 gross tons in 1938.

According to Shibata's report, an analysis of the records of 32 pair trawlers based in Taiwan from 1937 to 1938 revealed that the total number of trips made by these trawlers was 456, i.e., 38 trips per month, and the average numbers of trips and hauls per vessel were more than two trips and 100 hauls in the winter and less than one trip and 65 to 75 hauls in the summer. The main reason for the decrease in fishing activities in the summer season was that this period was used for the repair and maintenance of the fishing boats and for official inspection of the hulls.

The annual amounts of total catch by pair trawlers based in Taiwan are as follows[1/]:

Year	1931	1932	1933	1934	1935	1936	1937	1938
Catch in metric tons	9 621	8 513	12 810	15 492	22 901	22 249	25 725	27 255

These figures show a more or less steady increase over the years, the total catch in 1938 reaching a level three times higher than that in 1931. The main fishing grounds of the fleet were in the Strait of Taiwan and Taiwan Bank where smaller-sized otter trawlers (about 240 gross tons) were operating. Consequently, the exploitation of the fish stocks by pair trawlers in the wide area of the Mainland Shelf in the South China Sea may not have been very high.

It is not possible to analyse the annual changes of fishing activities by pair trawlers on the Mainland Shelf from Taiwan to Hainan Island because the statistics were combined with those in the waters north of 30°N in the East China Sea. Hence, the figures described above represent only the situation of fishing activity in the Taiwan Strait and Taiwan Bank, that is to say, only a local area of the northeastern corner of the Mainland Shelf of the South China Sea.

According to the catch statistics, the most abundant species caught in 1931 were yellow sea bream (Taius tumifrons) followed by croakers (Sciaenidae). However, in 1938 croakers became most important, followed by lizardfishes (Saurida spp.), and sea bream ranked only seventh in the species composition. It is a well known fact that the Japanese exploitation of the East China Sea by pair trawling in its early stage concentrated mainly on yellow sea bream. Therefore, the steady decline in the catch of this fish in these waters forced the fleet to move to more southern waters into the South China Sea. Shibata (1941) pointed out that this expansion resulted in a decrease of the stock size of this species on the Mainland Shelf. He forecasted that the catch of the lizardfishes would increase instead of yellow sea bream in these waters, and his prediction was confirmed by the Taiwan trawlers in the post-war years.

The activities of the Japanese pair trawlers in the northern South China Sea decreased rapidly after 1939 and stopped at the end of the second world war in 1945[2/].

1/ After annual fisheries statistics of Taiwan, 1938; original weight reported in Kan

2/ According to Ochi (personal communication) two Japanese fishing companies working with about 40 pair trawlers of 50-80 gross tons each during the most prosperous time operated from just before the second world war until almost its end from the port of Yu-Lin in the waters south of Hainan Island to the coast off Nha Trang in Vietnam. Unfortunately data on this fishery were lost during the war.

3.2 Fishing activities in the post-second world war years

3.2.1 Japan

In 1952, Japan sent a first post-war trawler fleet to the South China Sea. The fleet consisted of about ten otter trawlers of 480 gross tons in average and about 20 (10 units) pair trawlers of 90 gross tons in average. After 1957 about 50 pair trawlers were added to the fleet. These trawlers can be divided into three categories: (i) otter trawlers based in Japan; (ii) pair trawlers with a mothership of about 1 000 gross tons; and (iii) pair trawlers with a licence specifying Hong Kong as a base port and landing place. The number of the vessels licensed and the total catch from 1952 to 1963 are shown in Table 3.

Table 3. The number of the Japanese trawlers operating in the South China Sea after the second world war

Year	No. of vessels licensed		Total catch in metric tons
	otter trawlers	pair trawlers	
1952	10	4	3 079
1953	9	21	11 730
1954	9	22	12 045
1955	7	16	8 171
1956	8	22	8 389
1957	9	20	10 283
1958	18	56	16 461
1959	9	14	8 155
1960	2	12	5 647
1961	-	10	1 007
1962	-	4	384
1963	-	2	166

Japanese post-war otter trawlers had their base ports in Nagasaki, Tobata and Shimonoseki which are located in southern Japan facing the East China Sea. Most of them had a licence of operation both in the East China Sea and in the South China Sea. A few vessels operated in the South China Sea throughout the year. For example, in 1956 only four units or eight vessels of pair trawlers worked in these waters. Many other trawlers operated in the South China Sea only during the summer season. In the other seasons they worked in the East China Sea which is their home fishing waters.

The area fished by post-war Japanese trawlers in the northern South China Sea was restricted by the Government to west of 118°E and north of 15°N. The otter trawlers operated in waters between 20 and 100 metres in depth on the continental shelves, and the pair trawlers within 50 and 150 metres in depth. The main fishing grounds were located on the long belt of continental shelves about 120 miles off the coast of Mainland China from the southern point of Taiwan to the entry of the Gulf of Tonkin near Hainan Island, and in the waters within the Gulf. Therefore, the total area of their fishing grounds in the South China Sea was smaller than that of the East China Sea.

Most of the otter trawlers concentrated their fishing to waters within the Gulf as they did during the pre-war years. However, only a few pair trawlers fished in the Gulf and many other pair trawlers fished from the offshore waters of Hong Kong to off the southeast coast of Hainan Island. Though the waters between east of 116°E and west of 118°E are lawfully permitted for Japanese fishing activity, fishing has scarcely been done in these waters.

The details of species composition of the catches by post-war trawlers in these waters will be described later in this paper. According to the statistics of 1956, the major species were yellow sea bream (Taius tumifrons), lizardfishes (Saurida spp.), red sea bream (Argyrops cardinalis), and snappers (Lutjanus spp.). The catches of these four species amounted to 3 685 metric tons or 51 percent of the total of 7 181 metric tons of fish caught. The percentage of yellow sea bream, the top ranking fish, in the total catch was 18 percent. The golden threads (Nemipterus spp.) followed these four major species or group of species in importance. A difference was found between the species composition of the fish caught by otter and by pair trawlers, especially concerning yellow sea bream (Taius tumifrons) and snapper (Lutjanus spp.). The catches of yellow sea bream by pair trawlers were 581 metric tons or 24 percent of the total pair trawler catch whereas otter trawlers caught only 18 tons or less than one percent of their total catch. On the other hand, in the case of snapper (Lutjanus spp.), 581 metric tons (31 percent of the total) were caught by otter trawlers and 289 metric tons or only 5 percent by pair trawlers.

In general, otter trawlers caught more red sea bream and crevalles (Carangidae) than the pair trawlers. In the case of lizardfishes, white croaker and goatfishes (Upeneus spp.) pair trawlers did better than the otter trawlers. Accordingly, the ranking of the major species caught by otter trawlers was snappers, red sea bream, lizardfishes and golden threads, and that of pair trawlers yellow sea bream, lizardfishes, red sea bream and snappers. This difference in the composition of the catches between the two types of fishing may be due to the differences in fishing areas and in the characteristics of the gear.

The fishing activities of these trawlers in 1956 are summarized in Table 4.

Table 4. Fishing activities of the Japanese post-war trawlers in the South China Sea (S.C.S.) in 1956 compared with figures for the East China Sea (E.C.S.)

Type of gear employed	Catch per haul in kg	Per trip per vessel			
		No. of days absent from port	No. of days operated	Number of hauls	Catch in kg
Otter trawler					
S.C.S.	736	51.8	31.7	207.5	171 257
E.C.S.1/	571	23.1	18.1	104.4	57 889
Pair trawler					
S.C.S.	643	85.3	68.9	398.1	220 673
E.C.S.	571	19.2	14.5	183.8	48.143

1/ Figures for the East China Sea (Average of 1953 to 1956)

The form of fishing operation can be divided into several groups, e.g., the group based in Hong Kong, that in Japan, the group of mothership system, etc. Therefore, the number of days absence from port varied considerably. For otter trawlers, for instance, it ranged from 22 days on the average in one group up to 62 days in another group. For pair trawlers, the range of days absence from port was also very wide, from 24 days on the average up to 154 days.

Comparing these figures of the South China Sea with those of the East China Sea, the former shows somewhat higher values in the catch per effort than the East China Sea. Furthermore, it is remarkable that the fleet spent much more time and effort in the South China Sea.

After 1958, the number of Japanese trawlers operating in the South China Sea would have been increased rapidly, but the escalation of the war in Vietnam prevented this development. Moreover, the decline of the catch rate in these waters made them less attractive. Hence the fishing operations ceased in 1963. Recently, the Japanese Government permitted the pair trawlers again to operate in the South China Sea north of 10°N, in order to reduce the fishing intensity on the demersal stocks in the East China Sea. However, no vessel has operated in these waters up to the present.

3.2.2 Taiwan

3.2.2.1 General situation

The fisheries of Taiwan developed rapidly during the post-second world war years. With the motorization and mechanization of fishing vessels and their equipment, the country now possesses large stern trawlers of 1 900 gross tons as well as tuna motor longliners of 3 200 gross tons. The annual fish production has increased from 120 000 metric tons in 1940, the maximum in pre-war years, to 613 000 metric tons or 5.1 times in 1970.

The demersal fisheries in Taiwan can be divided into three categories: (i) otter and pair trawling operated in offshore or far distant waters, (ii) small or baby trawling including beam and spread trawls as well as drag nets which are operated mainly in the inshore waters, and (iii) many kinds of coastal fishing gear, such as beach seining, etc.

In the pre-war years, the number of large-sized vessels, such as otter and pair trawlers, was less than 100. However, in 1970 Taiwan had 102 otter trawlers, 381 pair trawlers (191 units) and more than 2 000 baby trawlers.

The annual production of demersal fishes of Taiwan is shown in Table 5. In 1954, the total demersal fish landings were about 40 000 metric tons or 24 percent of the total fish production including those of pelagic fishes and aquaculture. The demersal production rose rapidly to more than 277 000 metric tons or about 45 percent of the total fisheries production in 1970. About 50 percent of the demersal landings came from pair trawling and 30 percent from baby trawling. The remaining part consisted of catches by otter trawling and by coastal gear for bottom fishes.

The trawling grounds of the Taiwan fleet in the post-war years are in the waters of the northern Mainland Shelf from the Taiwan Strait to Hong Kong and the southern part of the East China Sea. Some large-sized otter and pair trawlers also fish in the southern parts of the South China Sea.

In the early period, in order to avoid troubles with the Mainland, the trawling grounds were limited to a small area in the southern part of the East China Sea. Thereafter, the fishing activities were expanded southward into the waters east of the centre line of Taiwan Strait. In 1956, good fishing grounds for lizardfishes were discovered around the Taiwan Bank, and this resulted in the enlargement of the size of the trawler fleet from 20 vessels in 1949 to more than 70 after 1956. The most dominant species of lizardfishes caught on the Taiwan Bank is *Saurida undosquamis*. However, it is believed that the size of the stocks of this species in these waters has rapidly diminished after only two or three years of exploitation. Hence, the value of the Taiwan Bank as a trawling ground decreased.

Table 5. Demersal fisheries statistics of Taiwan (1954-1970)
(unit: metric tons)

Year	Total fish production 1/	Demersal fisheries									
		Total demersal		Otter trawl		Pair trawl		Baby trawl		Coastal gears	
		Catch	% 2/	Catch	% 2/	Catch	%	Catch	%	Catch	%
1954	152 548	37 278	24.4	9 649	25.9	17 354	46.6	2 010	5.4	8 265	22.2
1955	180 618	50 330	27.9	11 483	22.8	23 772	47.2	4 340	8.6	10 735	21.3
1956	193 410	56 743	29.3	12 068	21.3	29 976	52.8	5 361	9.5	9 338	16.5
1957	208 121	66 024	31.7	13 039	19.8	36 767	55.7	6 018	9.1	10 200	15.4
1958	229 777	70 948	30.9	14 335	20.2	40 392	56.9	6 557	9.2	9 664	13.6
1959	216 327	86 209	35.0	18 152	21.1	49 237	57.1	8 092	9.4	10 728	12.4
1960	259 140	95 629	36.9	23 927	25.0	53 776	56.2	8 784	9.2	9 142	9.4
1961	312 439	118 895	38.1	27 019	22.7	71 240	59.9	9 497	8.0	11 139	9.4
1962	327 046	129 217	39.5	22 531	17.4	82 363	63.7	12 211	9.5	12 112	9.4
1963	350 720	144 497	41.3	18 690	12.9	90 581	62.7	17 067	11.8	17 217	12.0
1964	376 398	151 200	40.2	19 743	13.1	97 495	64.5	21 516	14.2	12 441	8.2
1965											
1966	550 276	624 112	48.0	18 541	9.0	126 362	61.9	49 500	24.3	9 720	4.8
1967	458 223	223 969	48.9	16 918	7.6	133 289	59.5	63 281	28.3	10 461	4.7
1968	531 020	238 940	46.6	21 272	8.9	140 198	58.7	69 016	28.9	8 454	3.5
1969	560 783	246 526	44.0	25 190	10.2	135 110	54.8	77 255	31.3	8 971	3.6
1970	613 152	277 098	45.2	44 363	16.0	137 676	49.7	86 951	31.4	8 108	2.9

1/ Including the production of pelagic fisheries and aquaculture

2/ The percentage of total demersal catch against the total fisheries production; the percentage in the other columns shows the percentage of the catch by various gear in relation to the total demersal landings

In 1958, the fleet moved westward to the waters off Hong Kong, where the trawling operations achieved great success. According to the experienced trawl fishermen in Taiwan, the major species in these waters are golden threads, bigeye (Priacanthus macrocanthus), lizardfishes, and crevalles (Carangidae). In 1960, their trawling grounds were extended from the waters of the south coast of Hainan Island to the waters off Saigon in Vietnam and off the coast near the Thai-Cambodian border in the Gulf of Thailand. Two base ports were established at Saigon and Nha Trang.

The main fishing season in the waters from Hainan to Nha Trang is in winter, and the major species caught are lizardfishes, croakers, bigeye and yellow sea bream. The fishing season in the waters of Saigon is during spring and summer, and the catches consist mainly of small-sized lizardfishes, snappers and shovelnosed lobster (Thenus orientalis). On the fishing grounds off the Thai-Cambodian border, mainly snappers are caught. Most of Taiwan's fishermen report that the size of this fish in this area is not so large, and believe that this area is not a good fishing ground economically.

Due to the escalation of the Vietnam war, the fishing activities in the waters of Vietnam have gradually decreased. The fleet moved southwestward to fish in the waters off the east coast of the Malay Peninsula and the northern coast of Borneo. These waters are exploited up to the present. It has been reported that the sizes of the demersal fish stocks in these two areas are fairly large. However, many of the fishes caught are not of high economic value, particularly catfish and certain carangids.

3.2.2.2 Fishery by large-sized trawlers and its production

The large-sized trawlers in Taiwan are based in the two ports of Kaohsiung and Chilung (Keelung). The number of vessels and their average gross tonnage during 1954-70 are shown in Table 6. The number of otter trawlers increased steadily from 21 vessels in 1954 to 57 vessels in 1960. In 1970 the number of vessels increased again suddenly to 102. The gross tonnage was about 135 on an average in 1970. The number of pair trawlers also increased steadily from 112 to 381 vessels during the same period. Their average gross tonnage was about 110 in 1970. According to the statistical yearbook of Taiwan for 1970, all otter trawlers have their homeport in Chilung (Keelung), and about half of the pair trawlers are also based in this port; the remaining half are in Kaohsiung. Kaohsiung has a somewhat more powerful pair trawler fleet, since the total gross tonnage is slightly higher than for Chilung.

The annual landings of the otter trawlers in Taiwan (Table 5) show an increase of about 4.6 times from 9 649 metric tons in 1954 to 44 363 tons in 1970. However, a substantial part of this increase occurred only in 1970, and for several years the landings remained between 15 000 and 20 000 tons, showing even a decrease between 1961 and 1967 although about the same number of vessels were in operation. In contrast to the other trawler landings those of the pair trawlers showed a rather steady increase from 17 354 tons in 1954 to 135 000-140 000 tons in 1968-70 (increase of about eight times).

Table 6. Annual changes in the number of large-sized Taiwanese trawlers and their gross tonnage

Year	Otter trawlers			Pair trawlers		
	No. of vessels	Total gross tonnage	Average per vessel	No. of vessels	Total gross tonnage	Average per vessel
1954	21	3 106	143	112	8 373	75
1955	23	3 337	145	131	10 177	78
1956	25	3 350	134	144	11 508	80
1957	26	3 621	139	151	12 178	81
1958	33	4 533	139	186	15 523	83
1959	59	8 402	142	219	18 488	84
1960	57	7 821	137	248	21 412	86
1961	57	7 782	136	282	25 419	90
1962	51	6 943	136	282	25 896	92
1963	48	6 337	132	287	26 342	92
1964	50	6 679	134	289	26 713	92
1965	49	6 620	135	308	29 485	96
1966	52	6 866	132	373	36 479	98
1967	57	9 048	159	378	36 948	98
1968	59	9 335	158	354	35 941	102
1969	64	9 820	153	370	38 692	105
1970	102	13 779	135	381	41 470	109

Table 7 indicates the annual changes in the catch per unit effort of large-sized otter and pair trawlers of Taiwan. It is evident that for the otter trawl fishery there is an overall decreasing trend in the average catch per vessel over the period 1955-70, with a particular decrease during 1957-60 and an increase since 1968. However, the average catch per vessel for the pair trawl fishery showed an overall increase during the same period.

Table 7. Annual changes in the catch per unit effort by large-sized Taiwanese trawlers (1954-70)

(unit: metric tons)

Year	Otter trawlers			Pair trawlers		
	No. of vessels	Catch per unit effort		No. of fishing units	Catch per unit effort	
		Annual total per vessel	Annual total per gross ton		Annual total per vessel	Annual total per gross ton
1954	21	460	3.1	56	310	2.1
1955	23	499	3.4	66	363	2.3
1956	23	525	3.6	72	414	2.6
1957	26	502	3.6	76	487	3.0
1958	33	434	3.1	93	434	2.6
1959	59	308	2.2	110	450	2.7
1960	57	420	3.1	124	434	2.5
1961	57	474	3.7	141	505	2.8
1962	51	442	3.2	141	584	3.2
1963	48	410	3.1	144	631	3.4
1964	50	395	3.0	145	675	3.6
1965	49	383	2.9	154	693	3.6
1966	52	357	2.7	187	675	3.5
1967	57	297	1.8	189	705	3.6
1968	59	361	2.3	177	792	3.9
1969	64	394	2.5	185	730	3.5
1970	102	435	3.2	191	721	3.3

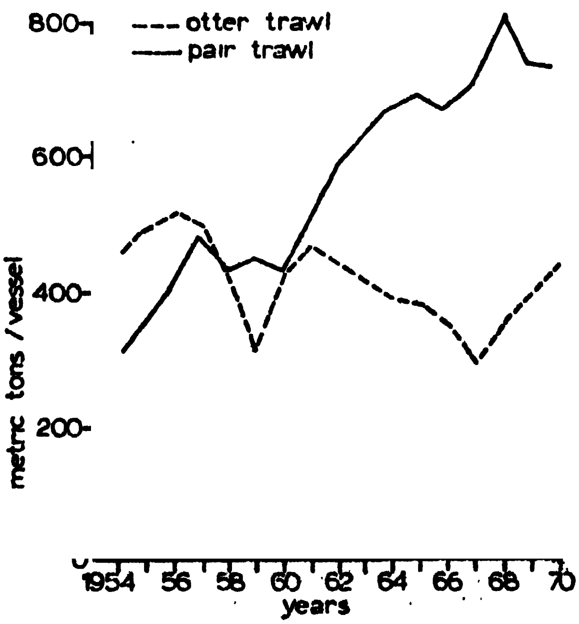

Figure 3. Annual changes in catch per unit effort of large-sized trawlers from Taiwan

3.2.2.3 Baby trawl fishery and its production

Presently, baby trawling using single small vessels ranging from 5 to 50 gross tons has become very popular in Taiwan. Most of them are small-sized wooden otter trawlers and a few are beam or drag net trawlers. These boats supply more fresh shrimps and fishes which have much higher economical value than those from large-sized trawlers. The number of days absence from port is only within a week or less than ten days. Because of the low costs and high returns, nowadays, baby trawling shows an astonishing development in Taiwan. The investment for this fishery can be made without much capital.

As shown in Table 8, the number of baby trawlers has increased markedly since 1961. In present years, the annual production from the baby trawlers has been more than 30 times higher than in 1951, and 9 times over the production in 1961. The size of the baby trawlers has also become larger from 5 gross tons in the average in 1954 to 16 tons or more in 1970. The home ports of the baby trawlers in Taiwan are distributed widely; however, most of these trawlers are concentrated in two main ports, Kaohsiung and Chilung.

Table 8. Number of vessels and gross tonnage of baby trawlers in Taiwan (1954-70)

Year	Number of vessels	Total gross tonnage	Average gross tonnage per vessel
1954	468	2 214	4.7
1955	558	2 623	4.7
1956	685	3 657	5.3
1957	867	4 802	5.5
1958	862	4 837	5.6
1959	918	5 518	6.0
1960	962	6 040	6.3
1961	1 044	7 122	6.8
1962	964	6 984	7.3
1963	1 195	8 529	7.1
1964	1 386	11 905	8.6
1965	1 501	13 666	9.1
1966	1 756	16 857	9.6
1967	1 979	23 310	11.8
1968	2 374	30 061	12.7
1969	2 278	32 886	14.4
1970	2 129	34 751	16.3

The fishing grounds of the baby trawlers are in the waters north off Taiwan and from Taiwan Strait to off Hong Kong. They overlap with those of the large-sized trawlers. However, many trawl fishermen in Taiwan have pointed out that the particular localities for fishing of the baby trawlers are different from those of the large ones, as these waters are untrawlable by large trawlers.

Generally speaking, they caught more high-priced fishes, including many kinds of shrimps, than large trawlers in the same one degree square.

As shown in Table 9 and Figure 4, the catch per unit effort (annual total per vessel) of baby trawlers had a gradual upward trend (eight to nine metric tons) from 1955 to 1961. From 1962 to 1970, the trend increased markedly to more than 40 tons in 1970. The change in the annual total landings per gross ton is almost similar.

Table 9. Annual changes in the catch per unit effort of the baby trawlers in Taiwan (1954-70)

(unit: metric tons)

Year	Number of Vessels	Catch per unit effort	
		Annual total per vessel	Annual total per gross ton
1954	468	4.3	0.9
1955	558	7.8	1.7
1956	685	7.8	1.5
1957	867	6.9	1.3
1958	862	7.6	1.4
1959	918	8.8	1.5
1960	962	9.1	1.5
1961	1 044	9.1	1.3
1962	964	12.7	1.7
1963	1 195	14.2	2.0
1964	1 386	15.5	1.8
1965	1 501	20.8	2.3
1966	1 756	28.2	2.8
1967	1 979	32.0	2.7
1968	2 374	29.1	2.3
1969	2 278	33.9	2.3
1970	2 129	40.8	2.5

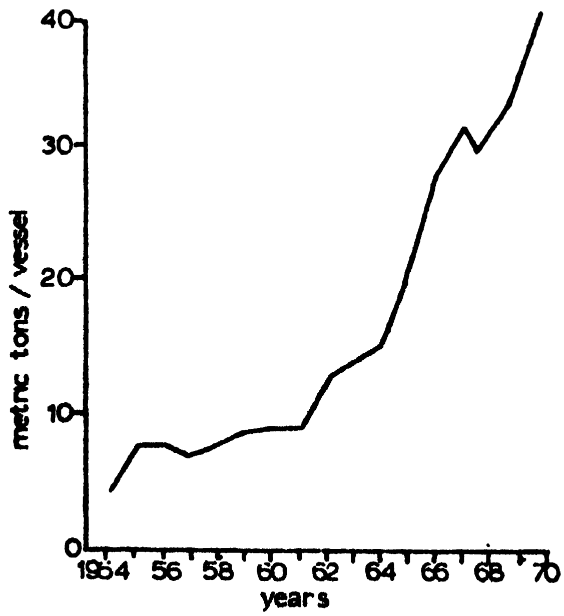

Figure 4. Annual changes in catch per unit effort of baby trawlers in Taiwan

The species composition of the catches in this fishery is rather different from that of the large-sized trawlers. The major species caught by otter trawlers are croakers (Sciaenidae), hairtail (Trichiurus haumela), conger pike eel (Muraenesox cinereus), rays, shrimps and lobsters, those of the pair trawlers are lizardfishes (Saurida spp.), hairtail, sea breams (Sparidae), squids and cuttlefishes and goatfishes (Upeneus spp.). On the contrary, baby trawlers catch more shrimps. In 1964 this fishery produced about one third of the total shrimp catch by weight. In 1967, although the amount of shrimps caught somewhat diminished, still 17 636 metric tons of shrimp (or 28 percent of the total of 63 281 tons) were caught, constituting 51 percent in value of the total production. Most of the shrimps caught are of medium-sized species, but the landings of large-sized shrimps are also fairly important. Croakers, lizardfishes, squids and cuttlefishes follow the shrimps as major components of the catches.

The baby trawl fishery enterprises are becoming economically rather strong and compete with those of the otter and pair trawl fisheries in the market. The Chinese Government now limits the construction of new baby trawlers in order to avoid over-competition.

3.2.3 Hong Kong

Several reports describing the demersal fisheries of Hong Kong have been published, e.g., Fisheries Bulletin, Nos. 1-3, Hong Kong 1970-72; Tiews, 1969, and papers submitted to the Symposium of the 13th Session of IPFC. In this paper, therefore, only a general outline of the fisheries is given.

The annual total landings in Hong Kong have increased with some fluctuations since 1945. The average annual landings (from April to March) during 1945-50 were little less than 6 000 metric tons; during 1955-60 they increased to about 40 000 tons, and reached recently (1970) about 71 000 tons (see Table 10). Hence, the total landings have increased more than ten times during the 25 years after the second world war.

Table 10. Annual total fish landings in Hong Kong

Year	Landings (metric tons)	Five major species (%)1/
1960	43 274	38.7
1961	46 181	38.5
1962	50 196	39.4
1963	52 231	42.4
1964	47 317	40.8
1965	49 805	35.3
1966	46 361	37.8
1967	53 425	32.5
1968	64 924	34.5
1969	69 978	32.4
1970	71 399	30.8
Annual average	54 099	36.1

Source: FAO and Fisheries Research Station in Hong Kong

1/ Golden threads (Nemipterus spp.), conger pike eel (Muraenesox sp.), lizardfishes (Saurida spp.), scads (Decapterus spp.), and bigeyes (Priacanthus spp.)

Most of the landings are composed of many kinds of demersal fishes with a few pelagic species, such as mackerels and sardines. The statistics broken down into reliable taxonomic categories since 1960 are being compiled. According to the preliminary tabulation, the golden threads (Nemipterus spp.) made up about 20 percent of the average total during the ten-year period and the conger pike eel (Muraenesox sp.) 7 percent, followed by lizardfishes (Saurida spp.). The species composition of the demersal landings changed annually with a certain tendency. In 1970, the landings of scads (Decapterus spp.) were the highest (9.6 percent of the total), followed by golden threads (8.9 percent) and bigeye (Priacanthus spp.) (4.8 percent).

The major fishing gear used for demersal fishing from Hong Kong are trawl nets and bottom longlines. The number of vessels is shown in Table 11.

Table 11. Number of fishing vessels engaged in demersal fisheries of Hong Kong (February 1969)

Type of vessels		Number of vessels
Beam trawler (Prawn)		
Native type	Large	929
	Small	491
Single boat stern trawler (Modern)		29
Pair trawler		
Native type	Inshore	144
	Deep sea	120
Modern	Deep sea	56
Total number of trawlers		1 769
Longliner (for golden thread)		
Native type	Large	60
	Small	671
Modern	Large	7
Longliner (for conger pike and shark)		
Native type	Small	123
Longliner (for grouper)		
Native type	Small	62
Handliner		
Native type	Large	40
	Small	547
Total number of liners		1 510

Source: Fisheries Bulletin No. 1, p. 40, 1970, Hong Kong

The demersal fishery of Hong Kong is now covering the waters of the northern Mainland Shelf from north of Hong Kong to the southwest of Hainan Island. The results of an analysis carried out by the Hong Kong Fisheries Research Station (Tiews, 1969) suggest that the reduction of the fishing intensity on the exploited fishing grounds was necessary. Hong Kong is attempting to explore new fishing grounds using new fishing methods. Exploratory fishing surveys conducted by R/V CAPE ST. MARY of Hong Kong using deep sea bottom longlines on the Macclesfield Bank in the southern part of the China Sea Basin gave favourable results.

3.2.4 Mainland China and North Vietnam

It is very difficult to evaluate the status of the demersal fisheries of Mainland China because of the lack of pertinent information. Based on the pre-war statistics, the total sea fisheries production including aquaculture in the Kwangtung and Fuchen Provinces which face the Taiwan Strait and from the northern Mainland Shelf in the South China Sea have been estimated as 200 000 metric tons for Kwantung and 150 000 tons for Fuchen (Shindo, 1964). It is believed that 90 percent of the total landings in the Kwangtung Province were demersal fishes. In the Fuchen Province about one third of the total production came from mariculture, and the remaining two thirds also included considerable amounts of pelagic fishes. Therefore, the demersal landings in this Province may be a little less than half of the total, that is, about 70 000 metric tons.

Consequently, the estimated total demersal landings from these two Provinces in the pre-war years would be 250 000 metric tons.

From indirect information on the development of sea fisheries of Mainland China and on the state of the fish resources in post-war years the landings up to 1960 are roughly estimated as about twice those of the pre-war years. After 1960, the landings have probably been at the level of about 500 000 metric tons annually (except Gulf of Tonkin).

The estimation of the present demersal landings from the Gulf of Tonkin and North Vietnam is more difficult than for the two districts described above. It is roughly estimated that these areas have a possible demersal production of 200 000 to 300 000 metric tons. Under the war conditions in Vietnam the production will probably be approximately 100 000-200 000 metric tons at present.

3.2.5 Thailand

3.2.5.1 General situation

The history of the demersal fisheries in Thailand is well summarized by Ruamragsa and Isarankura (1965). In its early period the Thai fishery was almost limited to fresh waters. Only some fishing had been operated in the shallow sea waters near the shore and its production was quite insignificant. Later, sea fisheries by means of bamboo stake traps and Chinese purse seining for catching some species of pelagic fishes, such as chub mackerel and anchovies, etc., developed. Demersal fisheries did not exist until the early fifties.

In 1952 trawling was first introduced into Thai waters by the Gulf Industry Co. Ltd. Four wooden vessels from 47 to 90 gross tons equipped with otter board trawl nets were used. They made six experimental hauls in the Gulf, but the results were not satisfactory due to the lack of experience of the crew in this area and the trials were discontinued. In 1953 experimental fishing in the Gulf was conducted by another fishing company. Although their attempts were also not successful because of lack of technical experience as well as difficulties of selling the catches in local markets, these experiments gave a good hint to the local sea fishermen. In the following year Thai fishermen invented a new kind of beam trawl for shrimps in very shallow waters using small vessels of less than 20 gross tons.

The results of this new demersal fishery were so satisfactory that it developed rapidly, and the new type of fishing gear was used in many coastal provinces in the Gulf of Thailand, replacing the old primitive gear such as shrimp push net.

The fishing grounds for the many bamboo stake traps and Chinese purse seining had been concentrated in the shallow coastal waters, and this resulted in a drastic decline in the abundance of most species of pelagic fishes with the exception of cuttlefishes and squids. Many bamboo trap fishermen invested therefore in the trawl fishery and many purse seiners were converted into trawlers. Therefore, these traps and seiners have almost disappeared from the Thai waters.

In 1961 experimental otter trawling was conducted in the Gulf by the Thai Government with the assistance of experts from the Federal Republic of Germany under the agreement between these two countries for economic and technical cooperation. After testing several types of demersal gear, they came to the conclusion that otter board trawling was most suitable for these waters. Encouraged by the Government, the otter trawl fishery in the Gulf expanded rapidly. The number of trawlers and the production of demersal fishes increased year by year (Tables 12 and 13). The total annual landings from trawl fishing in the Gulf amount to more than 70 percent of the total marine production of Thailand.

The annual changes in the catch rate from commercial statistics as shown in the right hand column of Table 12, indicate an upward trend with some fluctuations, except a very high value in 1961. Other data on the annual changes in the catch rate of commercial trawling in the Gulf are shown in Table 14. These figures were estimated recently by the staff of the Statistical Section of the Thai Department of Fisheries. It appears that the catch rate in kilogrammes per hour has increased for otter trawling, and no significant change is observed in the case of pair trawling.

Table 12. The Thai trawler statistics from 1961-70

(unit: metric tons)

Year	Total marine production	Trawl fishery			
		Total landings		Trawl units	Landing per trawl unit
		Landings	%1/		
1961		123 077		201	612
1962		151 403		976	155
1963	323 374	277 150	86	2 026	136
1964	493 196	371 642	75	2 360	158
1965	529 483	392 666	74	2 396	282
1966	635 165	448 554	71	2 695	166
1967	762 188	582 980	77	3 077	189
1968	1 004 058	784 164	78	3 182	247
1969	1 179 595	907 850	77	3 185	285
1970	1 335 690			3 114	

1/ Percentage shows that of total trawl landings in the Gulf against total marine production of Thailand. Basic data were obtained from the Statistical Section, Department of Fisheries, Thailand.

Table 13. The sizes and numbers of trawlers in Thailand, 1969-71 1/

Length of vessel in metres	Otter trawlers			Pair trawlers 2/		
	1969	1970	1971	1969	1970	1971
less than 14	826	685	843	22	15	19
14 to 18	906	966	1 056	80	80	89
18 to 25	207	425	421	146	115	155
more than 25			81			2
Total	1 939	2 076	2 041	248	210	265

1/ Data obtained from Statistical Section, Department of Fisheries, Thailand. These statistics have been available since 1969.

2/ Presented by fishing unit. One unit is composed of two vessels.

Table 14. Annual changes in the catch per unit effort of commercial trawlers operating in the Gulf of Thailand

(unit: kilogrammes)

Year	Otter trawlers		Pair trawlers	
	Catch per haul	Catch per hour	Catch per haul	Catch per hour
1969	146	38	433	132
1970	251	63	372	124
1971	227	58	453	123

These results based on the commercial statistics are opposite to the findings of scientific research which are described later. This discrepancy is explained by the enlargement and improvement of the vessels and gear, and the expansion of the fishing grounds beyond the waters originally exploited. According to more detailed information obtained during 1969-71 which is not shown here, the catch rate increased with the expansion of the fisheries into deeper waters, especially in the case of otter trawling. For example, the data indicate a catch rate of 24 kg per hour in the waters shallower than 14 metres, and of 205 kg in those deeper than 25 metres.

The towing period has become longer. At present, the average towing period is 3.9 hours for otter trawling and 3.3 hours for pair trawling. This practice may result in a decrease of the quality of the fish caught and in the efficiency of fishir

The towing period of Japanese trawlers operating in the East China Sea has become shorter year after year during the past 20 years. The average towing time is now two hours for otter trawl net fishing and one and a quarter hours for pair trawling.

The species composition of the catches from the trawl fishery in the Gulf of Thailand has also changed substantially. Recently, the amount of squids and cuttlefishes caught increased rapidly from about 11 000 metric tons in 1956 to about 60 000 tons in 1970. A large part of the catches consist of trash fishes, sometimes called "duck fish". These contain many species of small fishes less than 15 cm in length including the juveniles of several economically important species.

These trash fish are utilised not only as food for duck or poultry farming but also for catfish culture and in fish reduction plants which developed rapidly in recent years in this country. Some of the latter products are exported to Singapore.

3.2.5.2 Annual changes in the demersal stock size in the Gulf of Thailand as revealed from the results of a monitoring survey

With the increase in number of trawlers in the Gulf of Thailand a monitoring survey in the Gulf has been conducted annually by the Marine Fisheries Laboratory in Bangkok since 1963. The main purpose of this survey is to detect the changes in the density of the demersal fish stocks which are exploited. In the survey, R/V PRAMONG 2 (wooden stern trawler; 76 gross tons, 320 HP diesel), equipped with a German standard type trawl net is used. The regular survey of this vessel covers the entire coastal waters ranging from about 10 to 50 metres in depth in the Gulf from the Thai-Cambodian to the Thai-Malaysian borders.

Several papers on the details and analysis of the survey conducted by R/V PRAMONG 2 have been published (Ruamragsa and Isarankura (1965), Tiews (1967), Menasveta (1968), and Ritragsa et al. (1971)). According to the results of this scientific work the average catch in kilogrammes per hour in the Gulf decreased annually from 1961 to 1970 as shown in Table 15. The catch rate in 1961 was 297.8 kg per hour trawling, and that in 1970 was 97.44 kg or only less than 33 percent of that in 1961. The decreasing trend seems to be more marked from 1963 to 1966 and becomes gradually slower after 1966.

Table 15. Annual changes of the catch rate of R/V PRAMONG 2 in the Gulf of Thailand, 1961-70

Year	Number of hauls	Catch rate in kg/h	Catch rate in % of the base year, 1961
1961	133	297.80	100.00
1962		277.00	93.01
1963	200	256.00	85.96
1964	182	225.60	75.86
1965	192	179.20	60.17
1966	713	130.77	43.91
1967	713	115.05	38.63
1968	719	105.92	35.57
1969	720	102.74	34.50
1970	718	97.44	32.72

The surveys showed that the catch rate varies with the depth of water, becoming higher with greater depths. The general tendency is the same as in the case of the commercial vessels described previously. Generally speaking, the catch rates at every depth in the Gulf decreased more or less uniformly during the period from 1966 to 1970.

The highest catches were made in the southern part of the Gulf and the lowest in its eastern part, where the catch rate was comparatively the same during 1966 to 1970.

The composition of the catches by R/V PRAMONG 2 has changed. Some species of Loligo spp., Rastrelliger spp., and others have increased, whereas Carangidae were caught at nearly the same level from 1966 to 1970. The catches of most of the species have, however, decreased markedly year after year with some fluctuations.

It is believed that the decline of the catch rate is mainly due to the rapid increase of the fishing intensity and the number of trawlers operating in the Gulf. Although the marked decline of the catch rate in the early stage of a fishery, that is of a virgin fish stock, is a well known phenomenon, Gulland (1968) and Isarankura (1969)[1] have pointed out that the intensity of fishing in the Gulf had already in 1966 reached the level of the maximum sustainable yield. Meanwhile, the catch rate is still further decreasing. Several recommendations on management measures to protect the demersal fish stocks in the Gulf have been offered by the scientists concerned and the Thai Government is now considering the problems.

3.2.6 Malaysia

According to the report of the Malaysian Government (Tiews, 1969; Ministry of Agriculture and Lands, 1971), the fishing industry of West Malaysia has developed rapidly since 1957. The number of mechanized boats, particularly those with inboard engines, increased about ten times between 1957 and 1967. Parallel with this development new and more efficient types of fishing gear such as trawl nets and purse seines were introduced. As a result the fish production has increased from 113 000 metric tons in 1957 to 294 000 tons in 1970, or 2.6 times[2]

However, there has been a decline in the marine fish landings of Malaysia in recent years (Table 16) giving rise to concern that the inshore fishing areas may be overfished. In consequence, development of offshore fisheries of the country is planned.

Table 16. Marine fish landings in West Malaysia, 1966-70

Year	Landings (in metric tons)	Percentage of annual change
1966	236 000	+ 19.2
1967	301 000	+ 27.5
1968	339 000	+ 12.6
1969	297 000	- 12.4
1970	294 000	- 1.0

Two thirds of the fishermen of West Malaysia are working on the west coast and the remaining one third on the east coast bordering the South China Sea.

Trawl net fishing has become increasingly popular among the Malaysian fishermen, especially on the west coast or Indian Ocean side of West Malaysia. The landings by trawlers rose markedly from 56 000 metric tons in 1969 to 85 000 tons in 1970.

1/ According to Ritragsa (1971), Isarankura also mentioned the critical problems in his paper in Thai.

2/ Annual fisheries statistics of 1970, Ministry of Agriculture and Lands, West Malaysia, 1971.

As the trawl fishery expands, fishermen in West Malaysia begin to use more powerful vessels. Both inboard and outboard engines with stronger power are being employed. More than 70 percent of all licensed vessels are motorized in this country. A similar trend is also to be found in Sabah and Sarawak.

Judging from the Annual Fisheries Statistics issued by the Government, the total landings for 1970 in West Malaysia and Sarawak from the South China Sea are estimated at 110 000 metric tons and 10 000 tons respectively. Therefore, the estimated overall Malaysian demersal landings, including those in Sabah from the South China Sea, may be 130 000 metric tons, supposing that Sabah's landing is equal to that of Sarawak.

3.2.7 Other countries

3.2.7.1 South Vietnam and Khmer Republic

According to the statistics of the Government of South Vietnam, the total marine production in 1969 was 355 000 metric tons (U.S. Agency for International Development, 1970). It is difficult to subdivide this figure into demersal and pelagic components by estimation. Supposing two thirds of the total marine production is demersal, 237 000 tons is given for demersal landings. For the Khmer Republic (Cambodia) the total demersal catch has been estimated as about 30 000 metric tons (based on FAO Yearbook of Fisheries Statistics, Vol. 30).

3.2.7.2 Singapore

According to the Annual Report (1970), Primary Production Department, Government of Singapore, 118 otter trawlers with inboard engine were recorded, and the total marine production from many types of gear including trawl nets was 17 405 metric tons. Judging from the proportion of the number of vessels employing a particular type of gear, the share of the demersal catch in the total landings is estimated as about two thirds, that is, around 11 000 metric tons, the major portion of which came from the South China Sea.

3.2.7.3 Indonesia

Fishing activities of Indonesia in the South China Sea are restricted mostly to the inshore waters of the east coast of Sumatra Island. It is said that 855 baby trawlers of about 15 gross tons are operating in these waters, especially in the Strait of Malacca. Consequently, it is considered that the demersal production from the South China Sea must be very small even if the catches with other types of coastal gear for demersal fish in this area are included.

3.2.7.4 Philippines

The trawl fishery in the Philippines started as early as about 1900 when sailing "utase", a kind of Japanese style beam trawler, were used. It is said that it was around 1940 that they were generally changed into motorized otter trawlers. Trawling is now a well established fishery in this country. In its early stage, trawling in the Philippines was restricted mostly to areas such as Manila Bay and Lingayen Gulf. However, as the vessels became bigger and the trawl fleet enlarged, the fishing area was expanded to other bays and inter-island waters (Warfel *et al.*, 1950; FAO/UNDP, 1970).

According to the results of several exploratory trawling surveys, fairly good catches can be obtained in the waters off Palawan with 100 to 200 metres in depth. Bigeye (*Priacanthus* sp.), roundscad (*Decapterus russellii*) and lizardfishes (*Saurida* spp.) are important components of the trawl catches in this area.

Generally speaking the present trawling industry of the Philippines has not coped with the rapid improvements made in many other countries. The present annual demersal production from the South China Sea side including that of baby trawlers for fish and shrimps operating along the west coast of Luzon may be less than 50 000 metric tons.

4. ESTIMATION OF THE STANDING STOCKS OF DEMERSAL FISHES IN THE SOUTH CHINA SEA

4.1 Intercalibration of fishing power among different vessels

For the estimation of the absolute abundance or the index of abundance and stock density data from many research vessels and commercial fishing vessels operating in the area are used. The intercalibration of fishing power among the vessels and standardization of these data are essential for such an estimation. For the present paper, a comparison of the fishing power of 17 research vessels or groups of vessels in the case of commercial fleets was made (Table 17), using the method of employing the ratio of catch per unit effort between two different vessels (or groups of vessels) which operate at the same time and in the same place.

Table 17. List of research vessels and commercial fleets used for intercalibration of fishing power

Number	Name of vessel or fleet	Gross tonnage	Horse power	Years	Number of hauls	Number of squares operated	Remarks
1	Otter trawler fleet	ca 500		1931-38	10 893	17	Japan 1/
2	Otter trawler fleet	ca 240		1935-38	438	15	Japan 2/
3	Pair trawler fleet	70	ca 88	1938	9 612	26	Japan 3/
4	Otter trawler fleet	ca 480		1956	2 404	18	Japan
5	Pair trawler fleet	ca 90	ca 250	1956	8 408	30	Japan 4/
6	R/V HAI CHING		380	1960-63	640	37	Taiwan
7	R/V MANIHINE		220	1955-56	143	26	Singapore
8	R/V CAPE ST. MARY		385	1961-64	34	7	Hong Kong
9	TENYO MARU		1 000	1966	10	4	Japan
10	R/V PRAMONG 2	76	320	1963-64	243	11	Thailand
11	R/V PRAMONG 3		250	1963-64	57	4	Thailand
12	KYOSHIN MARY NO. 52	314	1 000	1969-71	1 137	108	FAO - Vietnam
13	R/V BAEK DU SAN	150	550	1967	50	18	South Korea
14	R/V KAIYO MARU	2 540	3 800	1968-71	37	8	Japan
15	R/V CHANGI	350	1 000	1970-72	86	71	SEAFDEC
16	Modern Japanese pair trawlers	ca 140	500	1969	644	2	Japan 5/
17	M/V Paknam	350	1 000	1971	6	2	SEAFDEC

1/ Large-sized trawlers operated in the Gulf of Tonkin in pre-second world war years; number of hauls is an annual average (four hours towing)

2/ Small-sized trawlers operated in the northern South China Sea in pre-second world war years; number of hauls is an annual average (four hours towing)

3/ Fleet with home port in Taiwan and operated in pre-second world war years. The gross tonnage and horse power should be doubled, because the fishing unit for pair trawling is composed of two vessels (two hours towing)

4/ Numbers 1 to 5 include some night operations

5/ Eight vessels of Tokushima Fishing Co. Ltd. in Japan

Source: No. 1: Ushioku (1935a) and Shibata (1940); Nos. 2 and 3: Ushioku (1935b) and Shibata (1941); Nos 4 and 5: Fukuoka Fisheries Adjustment Office, Japan (1958); Nos. 6 to 11: Lester (1967); No. 12: FAO (1972); No. 13: Fisheries Research and Development Agency, South Korea (1968); No. 14: Research Department, Fisheries Agency, Japan (1971); No. 15: Marine Fisheries Research Department, SEAFDEC (1972); No. 16: Minato-shinbun, Japan (1969); No. 17: Training Department, SEAFDEC (1971a) and (1971b).

Most of the published and unpublished data used in the present paper were arranged in different order, since each of the original authors had a different purpose and/or different point of view. The divisions of areas, statistical unit areas, and units of fishing effort, etc., are different. Moreover, the weight unit used is also different from country to country. In this paper, therefore, as necessary, a re-arrangement of the original figures was made. All of these data were converted into the same area unit, namely 1° squares, and all catch rates into kilogrammes per hour. In cases where the original data were not available, figures of different sizes of unit areas as calculated by the author concerned were also used.

Disregarding the time of operation, all combinations between two different vessels among these 17 research and other vessels were made, and the ratio of fishing power of each combination was computed. The ratio is calculated by the following formula:

$$rA/B = \left\{ \sum_{i=1}^{N} (Cai/h) \right\} / \left\{ \sum_{i=1}^{N} (CBi/h) \right\}$$

Where:

N = number of squares where vessels A and B operated

Cai/h = catch in kilogrammes per hour of vessel A in square $\underline{i}$

CBi/h = catch in kilogrammes per hour of vessel B in square $\underline{i}$

rA/B = ratio of catch rate of vessel A to vessel B

The ratios $\underline{r}$ for various combinations are shown in Table 18.

Ideally, to standardise the fishing power of a fishing vessel, that vessel should fish along a standard fishing vessel at the same time and place. However, the data obtained from such operations are very rare. Therefore, in this report, catch rates obtained from any two vessels fishing at any time during a three-year interval in relatively the same area were used in the standardisation of the fishing power, assuming that the catch rate of a vessel remained the same during that period.

In Table 18 the ratios of the catch rates of three fishing vessels, namely KYOSHIN MARU NO. 52, R/V CHANGI and R/V PAKNAM, are relatively the same being close to 1.0. Hence, the three vessels were used as standard vessels in the calculation of the fishing power of the other vessels. The values of $\underline{r}$ actually used for the standardisation of the fishing power are underlined in the Table.

The presumption that the three vessels have the same "fishing power index" is reasonable since the engine power of these three otter trawlers is 1 000 HP, and the sizes of the vessels are relatively the same, ranging from 314 to 350 gross tons.

The fishing power indices of other vessels were established. In those cases where $\underline{r}$ could not be obtained by direct comparison due to the lack of data available, $\underline{r}$ was computed indirectly step by step using an intermediary vessel whose $\underline{r}$ was already known by direct comparison.

Regarding the index for R/V MANIHINE which conducted trawl surveys in the South China Sea many years earlier than other vessels, $\underline{r}$ was also calculated directly by the same method described above without considering the time of survey due to lack of data.

From the analysis of annual changes in the fishing power of the Japanese fleet it has been found that the fishing power of the modern Japanese pair trawler is at least 1.5 times higher than that of the post-war Japanese pair trawler fleet operating about 1956. Hence $\underline{r}$ of the post-war Japanese pair trawler fleet was estimated as 3.00 in the East China Sea (by

the simple calculation of 4.41 x 1/1.5 or 4.41 x 0.67). Then, r of the post-war Japanese otter trawler fleet was estimated as 1.68 (3.00 x 0.56). Following the same method, the r of the pre-war Japanese pair trawler was estimated roughly at half of that of the post-war pair trawler fleet, that is, 1.50. Based on this figure, r of the pre-war fleet of large-sized otter trawlers was computed as 1.50 and that of small-sized ones as 0.53.

The fishing power indices obtained in this way are shown in Table 19. Judging from the indices presented in this table, the following comments can be made:

(1) The r of TENYO MARU (No. 9) seems to be somewhat smaller compared with the horse-power of its engine. The main reason is the lack of experience and knowledge on the part of the fishermen in the waters in which the vessel operated. The vessel completed only ten hauls.

(2) The r of R/V BAEK DU SAN is much higher in spite of the fact that the size and power of the vessel are smaller than those of the standard vessels. The main reason is that their fishing locations were close to the coast, especially the northern coast of Borneo. In general, the density of fish stocks is particularly high in coastal waters in tropical areas. The high value of r of R/V PRAMONG 3 may be due to the same reason.

(3) The high r values of R/V PRAMONG 2 and 3 may be due to the fact that there exists good knowledge about the fishing and environmental conditions in the Gulf of Thailand.

The high value for the modern Japanese pair trawlers indicates a very strong fishing power of this type of fishing vessel. From Japanese experiences on the trawling grounds in the northern Pacific it seems that the fishing power of a modern pair trawler of about 150 to 200 gross tons is almost equal to that of a large 3 000 gross ton stern trawler. The results presented in this paper show a value for r of a modern Japanese pair trawler (about 150 gross tons) of about 4.4, and for R/V KAIYO MARU (2 540 gross tons stern trawler) about 4.0. The difference in fishing power between the otter and pair trawlers is due to gear construction and method of fishing.

4.2 Estimation of indices of stock density and size of demersal fishes in the South China Sea

The catch rate given in kilogrammes per hour trawling of each vessel can be converted into that of a standard vessel by dividing the catch rate by the power index listed above. Then, the standardized catch rates of vessels operating in the same square are averaged. Thus, the standardized average catch rate, i.e., the corrected catch in kilogrammes per hour trawling, is obtained for every square in the area covered by the 17 vessels and/or commercial fleets.

The geographical distribution of the standardized average catch rates before and after the war are given in Figures 5 and 6. A detailed examination of these figures from the ecological standpoint will be made later in this paper.

The indices of stock density and stock size in each subarea were computed using the following formula:

$$\text{Stock density index} = \left(\sum_{i=1} d_i\right) / n$$

$$\text{Stock size index} = A \left(\sum_{i=1}^{n} \frac{d_i}{i}\right) / n$$

Tab. 8. The ratio of fishing power between two vessels (or groups of vessels) operating in the South China Sea

X

Vessel Nos.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1.00		(7) 1.00	(14) 1.01	(17) 1.32	(6) 0.53	(2) 0.69	(3) 0.67				(7) 0.36		(3) 0.39		(2) 1.21	
2		1.00	(9) 2.90		(1) 3.60												
3	(7) 1.00	(9) 0.35	1.00	(5) 0.63	(9) 2.04							(5) 0.25		(4) 0.99			
4	(14) 0.99		(5) 1.58	1.00	(15) 1.77							(15) 0.30		(3) 0.47		(2) 1.56	
5	(17) 0.76	(1) 0.28	(9) 0.49	(15) 0.56	1.00							(9) 0.15		(4) 0.33		(2) 0.84	
Y 6	(6) 1.89					1.00		(2) 1.06	(1) 0.49	(5) 1.93		(35) 1.61	(6) 7.90		(24) 1.31		(1) 1.43
7	(2) 1.44						1.00	(1) 1.03				(6) 1.54	(2) 13.57		(9) 2.41		
8	(3) 1.50					(2) 0.94	(1) 0.97	1.00				(7) 1.56	(1) 15.76	(1) 4.25	(7) 2.59		(1) 0.98
9						(1) 2.03			1.00			(1) 2.24	(2) 0.81		(2) 5.00		
10						(5) 0.52				1.00	(2) 2.05	(10) 0.68			(11) 0.92		(1) 0.92
11										(2) 0.49	1.00	(3) 0.72			(4) 0.63		
12	(7) 2.78		(5) 3.94	(5) 3.32	(9) 0.68	(35) 0.62	(6) 0.65	(7) 0.64	(1) 0.45	(10) 1.46	(3) 1.38	1.00	(6) 3.05	(4) 2.41	(76) 1.06	(2) 4.41	(2) 1.02
13						(6) 0.13	(2) 0.64	(1) 0.06	(2) 1.24			(6) 0.33	1.00		(25) 0.37		

Table 18. The ratio of fishing power between two vessels (or groups of vessels) operating in the South China Sea (Continued)

X

Vessel Nos.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
14	(3) 2.56		(4) 1.01	(3) 2.11	(4) 3.05			(1) 0.24				(4) 0.41		1.00	(1) 0.12	(2) 0.30	(1) 0.24
15						(24) 0.76	(9) 0.45	(7) 0.39	(2) 0.20	(11) 1.08	(4) 1.59	(76) 0.94	(25) 2.73	(1) 5.35	1.00		(2) 0.33
16	(2) 0.83			(2) 0.64	(2) 1.19							(2) 0.23		(2) 3.38		1.00	
17						(1) 0.72		(1) 1.02		(1) 1.08		(2) 0.98		(1) 4.14	(2) 1.21		1.00

Note: All lines show the ratio X/Y, and the figures in parentheses show the number of squares in the calculation

The underlined figures refer to vessels which fished in the same area at about the same time. Only these were used for the calculations of relative fishing power.

Table 19. Fishing power indices assigned to the vessels operating in the South China Sea

Vessel number	Name of vessel or fleet	Fishing power index	Remarks
12	KYOSHIN MARU NO. 52	1.00	Standard
15	R/V CHANGI	1.00	Standard
17	M/V PAKNAM	1.00	Standard
9	TENYO MARU	0.33	Average against KYOSHIN MARU and R/V CHANGI
13	R/V BAEK DU SAN	2.89	Average against KYOSHIN MARU and R/V CHANGI
14	R/V KAIYO MARU	3.97	Average against KYOSHIN MARU, R/V CHANGI and M/V PAKNAM
16	Modern Japanese pair trawlers	4.41	Against KYOSHIN MARU
6	R/V HAI CHING	0.91	Through the r of TENYO MARU
8	R/V CAPE ST. MARY	0.97	Through the r of R/V HAI CHING
10	R/V PRAMONG 2	1.76	Through the r of R/V HAI CHING
11	R/V PRAMONG 3	3.60	Through the r of R/V PRAMONG 2
7	R/V MANIHINE	0.62	Disregarding the time of survey
5	Post-war Japanese pair trawler fleet	3.00	Through the r of modern Japanese pair trawlers
4	Post-war Japanese otter trawler fleet	1.68	Through the r of post-war Japanese pair trawler fleet
3	Pre-war Japanese pair trawler fleet	1.50	Through the r of post-war Japanese pair trawler fleet
1	Pre-war large otter trawler fleet	1.50	Through the r of pre-war Japanese pair trawler fleet
2	Pre-war Japanese small otter trawler fleet	0.53	Through the r of pre-war Japanese pair trawler fleet

Where:

i = Square

n = Number of squares in subarea

di = Catch rate (standardized average catch in kilogrammes per hour trawling) in square i

A = Areas counted by squares or unit areas in Table 1

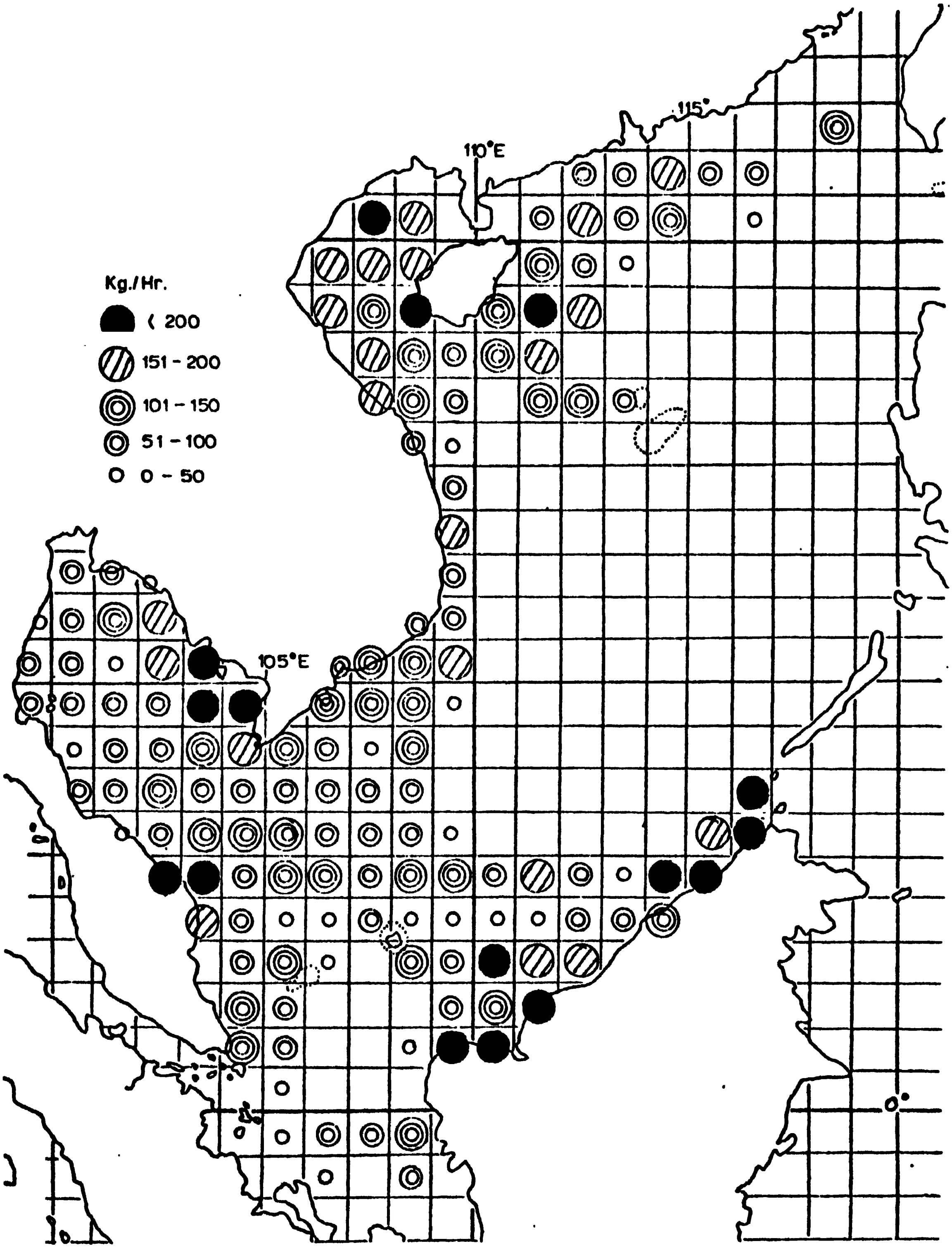

Figure 5. Geographical distribution of catch rates after the second world war

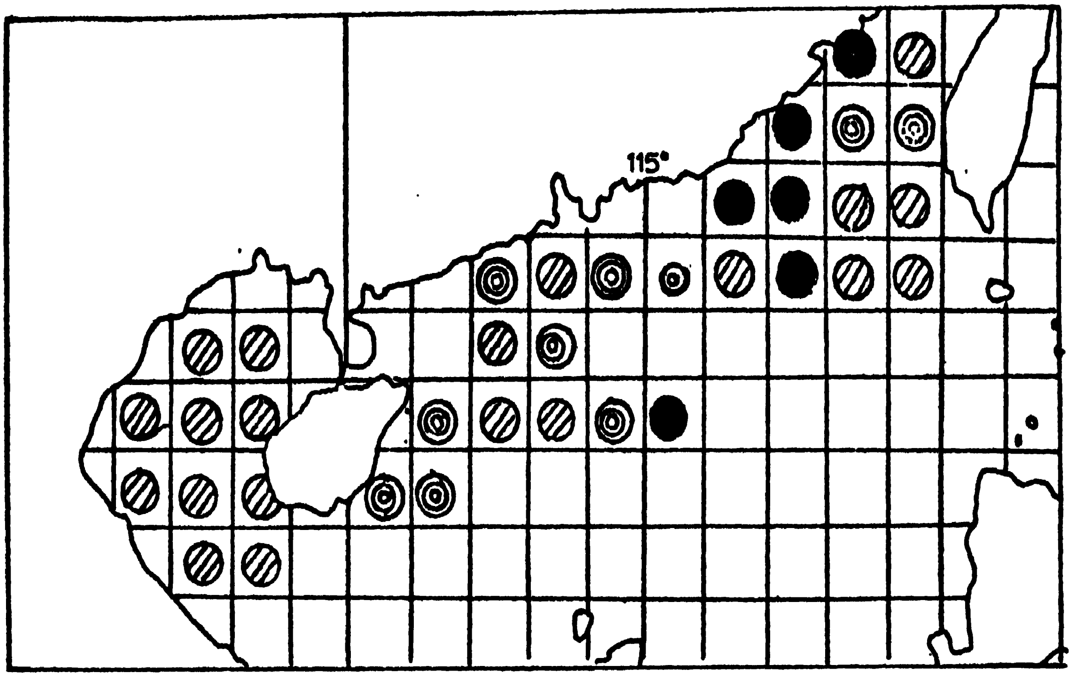

Figure 6. Geographical distribution of catch rates before the second world war (symbols are the same as in Figure 5)

It is apparent from Table 20 that the area with the highest density is the Gulf of Tonkin (index = 170). The Gulf of Thailand (169) in its early years ranks second, followed by the eastern Sunda Shelf (153). The area with the lowest density might possibly be the Luzon-Palawan Region, but it is difficult to draw any definite conclusion because of the lack of pertinent information for these waters. The Karimata-Gasper Region and the southern Sunda Shelf show low values, 53 and 70 respectively.

The average stock density on the Mainland Shelf (sum of upper three subareas in the Table) is 118 and that of the Sunda Shelf (sum of five subareas in the middle part of the Table and Karimata-Gasper Region) is 102. The density index for the overall South China Sea is 97.

The indbx of stock size for the present years is highest for the eastern Sunda Shelf (2 861), followed by the northern Mainland Shelf (2 750). The lowest is that for the northern Sunda Shelf (735). The index of stock size for the southern Mainland Shelf is 778, with the exception of the Luzon-Palawan Region where it is presumably rather negligible. Hence the index for the total Mainland Shelf is 5 415 and for the total Sunda Shelf (including Karimata-Gasper Region) 11 307. Thus, the stock size of demersal fish on the Sunda Shelf is about twice as high as that of the Mainland Shelf. The index of stock size for the whole South China Sea is 15 253.

Table 20. Indices of stock density and stock size of the demersal fishes in each subarea of the South China Sea from survey data

Subarea	No. of squares	Period of survey	Index of stock density	Index of stock size
Northern Mainland Shelf	27.5	1931-38	177	4 686
		1956	100	2 750
Gulf of Tonkin	11.1	1935-38	171	1 898
		1956	170	1 887
Southern Mainland Shelf	7.2	1969-71	108	778
Northern Sunda Shelf	7.0	1969-71	105	735
Central Sunda Shelf	22.3	1969-71	107	2 386
Gulf of Thailand	24.5	1961	169	4 141
		1970	55	1 347
Southern Sunda Shelf	26.6	1969-71	70	1 862
Eastern Sunda Shelf	18.7	1969-71	153	2 861
Karimata-Gasper Region	12.2	1969-71	53	647
Luzon-Palawan Region	4.1	1969-71	-	-
Total area and average of the indices	157.1 1/	1969-71	97 2/	15 253

1/ Luzon-Palawan Region is not included in the total

2/ In the case of two different periods, the more recent data used

4.3 Comparison of indices of stock density and stock size between the post-war and pre-war years

Unfortunately, data on the indices of stock density and stock size in pre-war years are available only for two subareas, namely the northern Mainland Shelf and the Gulf of Tonkin. Following the same procedure as described in 4.2, the indices of stock density and stock size on the northern Mainland Shelf in pre-war years (1931 to 1938) were calculated as 177 and 4 686 respectively, and those of the Gulf of Tonkin as 171 and 1 898 (see Table 20).

Comparing these indices of the pre-war period with those for the post-war period, it becomes evident that the stock density and size on the northern Mainland Shelf decreased markedly from 177 to 100, i.e., to 57 percent. However, from the geographical distribution of the catch rates as shown in Figure 6, it appears that high density was observed in the northern part of the Shelf, such as Taiwan Strait and its southwestern waters. Unfortunately, for post-war years data for these areas are almost non-existent as shown in Figure 6. This may cause bias in the comparison of density and the result described above should therefore be considered with some caution. But the lack of data in the northern part of the Mainland Shelf was due to the fact that the Japanese post-war pair trawler fleet did not operate there, and it may be considered that this means the density of the stock there had already decreased to a very low level around 1956.

The indices of stock density and stock size in the Gulf of Tonkin show almost the same level in pre-war and post-war years: 171 and 1 898 in pre-war against 170 and 1 887 in post-war years. There is no significant change.

4.4 Comparison of the indices of stock density and stock size between the South China Sea and the East China and Yellow Seas

4.4.1 The post-war years

In recent years from 1967 to 1970, the average catch per hour trawling computed from the data of about 45 000 hauls made annually by Japanese pair trawlers in the East China Sea and the Yellow Sea (excluding those in coastal waters) was approximately 405 kg. An average fishing power index for these pair trawlers was estimated roughly at 3.5 to 4.0, that is a little less than that for the modern pair trawlers shown in Table 21 (No. 16). The catch rate of 405 kg per hour was converted into that of a standard vessel, resulting in an average of 110 kg per hour. This figure is nearly the same as that for the whole South China Sea, which is 97.

The overall area of the East China Sea and the Yellow Sea (to north of Taiwan, depths 100-200 metres) has been estimated at 950 000 km^2 (Shomura, 1970). This area corresponds to 90.2 in the unit of "Area converted" in Table 1. In order to compare the stock sizes between the two seas under the same conditions, the areas of the continental slope from 200 to 500 metres in the southeastern part of the East China Sea were added to the above area. These deeper waters were estimated roughly as approximately 10 percent of the total areas under 200 metres in the sea. Therefore, the index of stock size in the East China and the Yellow Seas was computed using the following equation:

110 (density) x 90.2 (areas) x 1.1 = 10 914

Comparing this value with those in Table 20, the index of stock size on the Mainland Shelf is about half of that of the East China and Yellow Seas, and that of the Sunda Shelf is almost the same or a little larger (less than 4 percent) than that of the East China and the Yellow Seas.

4.4.2 The maximum stock densities and stock sizes

It is interesting to compare the indices of stock density and stock size of the unexploited stocks between the South China Sea and the East China Sea. In order to obtain these values, the maximum densities observed in the past in the heavily or moderately exploited waters, namely the northern Mainland Shelf, the Gulf of Thailand as well as the East China and the Yellow Seas, must be estimated. The Gulf of Tonkin had been exploited more or less intensively during short periods; however, the density of the pre-war and post-war periods show almost the same values. It is believed that the present war in Vietnam has limited the fishing activities in these waters, thus maintaining the stock size at relatively the same level.

Table 21 shows the estimated indices of stock density and stock size of demersal fish in areas of the South China Sea, the East China and Yellow Seas at their maximum density level. Combined and re-arranged, the indices are as shown in Table 22.

It is apparent from Tables 20 to 22 that the index of stock density in the East China Sea and the Yellow Sea is much higher than in the South China Sea, the value for the former being 2.4 times higher than that of the latter. The stock size of the former is also about 1.5 times larger than that of the latter, in spite of the smaller area of the former. The index of stock size of the northern Mainland Shelf including the Gulf of Tonkin is about 25 percent of that of the East China and the Yellow Seas, and that of the Sunda Shelf, including the Gulf of Thailand, is about 40 percent of the latter. This probably indicates that the basic productivity in the East China Sea and the Yellow Sea is much higher than that in the South China Sea. The East China Sea and the Yellow Sea have supported the activity of more than 1 000 large trawlers (including those of Mainland China) and the annual production amounts to 1.6 million metric tons (Shindo, 1968).

Table 21. Estimation of indices of stock density and stock size at their maximum levels

Area	Areas ('000 km^2)	Index stock density	Index stock size
Northern Mainland Shelf	27.5	177	4 868
Gulf of Tonkin	11.1	171	1 898
Gulf of Thailand	24.5	143 2/	3 504
East China and Yellow Seas	99.2 1/	301 3/	29 859

1/ Including the waters from 200 to 500 metres in depth

2/ Density in 1961 which was estimated from the data in Table 20 and from Table 14

3/ The maximum density of the stocks in the East China and the Yellow Seas was estimated for 1939 (Shindo, 1968). The index of that year was estimated as at least 1.5 times higher than that for the period 1952-55, which is the highest value for post-war years. The index of the latter has been estimated roughly as more than 600 kg per haul. Consequently, the maximum level in 1939 should have been at least 900 kg per haul. Considering the fishing power of vessels and hours of towing (two-hour period) in the pre-war pair trawling, this value is converted into that of standard vessels in this paper, resulting in a figure of 301 kg per hour trawling

Table 22. Indices of stock density and stock size in the South China Sea (Mainland Shelf and Sunda Shelf) and the East China and Yellow Seas at their maximum levels

Area	Areas ('000 km^2)	Index stock density	Index stock size
Mainland Shelf	45.8	165	7 544
Sunda Shelf	111.3	108	11 995
Overall South China Sea	157.1	124	19 539
East China and Yellow Seas	99.2	301	29 859

However, as described above, the present size of the demersal fish stocks in the South China Sea is approximately 1.5 times larger than that of the East China and the Yellow Seas, because of the marked decline in the abundance of demersal fish in the latter Seas.

4.5 Estimation of the standing and potential stocks of demersal fish in the South China Sea

Table 22 gives the estimates of standing stock in terms of relative abundance. For most purposes these should be expressed in absolute terms.

In order to estimate the size of a standing stock of fish, the actual amount of fish in a unit area of sea bottom has to be known. Following the report of KYUSHIN MARU NO. 52 (Kyokuyo Fish. Co. Ltd., 1972), one of the "standard vessels", the area swept by the trawl net per hour was estimated as 0.14 km^2.1/

The density of fish (weight per km^2) might then be estimated by dividing the catch per standard hour by 0.14. However, not all the fish in the path of the trawl are caught, and a proportion escape over or round the net.

Tiews (1969) estimated that this rate is about 50 percent. The same rate was used in the analysis presented in this report. The standing stock density and the stock size were estimated using the following formula:

(1) Standing stock density $(d') = \frac{1}{E} \cdot d \cdot \frac{1}{a}$

Where:

E = Rate of Escapement (= 0.50)

d = Catch rate in kg per hour

a = Area covered by the net in one hour (hectares)

(2) Standing stock size = d' X Areas (in hectares)

Confirmation that the escapement, at least for KYUSHIN MARU NO. 52 (one of the standard vessels), is provided by the comparisons of this vessel's catches and those of R/V PRAMONG 2, It was found that the catch rates were 81 kg per hour and 106 kg per hour respectively. However, KYUSHIN MARU's net covered a 50 percent greater area per unit time, so the catches per unit area covered were in the ratio of 81:106 x 1.5 or 1:1.97, approximately 1:2. Since some fish must escape from the net of PRAMONG 2 the proportion escaping from KYUSHIN MARU NO. 52's net must be more than 50 percent.

The factor for converting catch rates to density $(\frac{1}{E} \times \frac{1}{a})$ derived from the above estimates (E = 0.5, a = 1.4), i.e., 1.43, may therefore be too low, and a figure of 1.67 has been used here.

The estimated densities and the sizes of the standing stock of demersal fish in different parts of the South China and in the East China Sea and Yellow Sea are presented in Table 23.

The data for the East China Sea in the table provide an independent check on the validity of the estimates and especially of the conversion from catch rates to stock density. Concerning the demersal fish stock in the East China Sea, the average fishing mortality coefficient $\underline{F}$ of major species has been estimated at about 0.9 (Shindo, 1972). Based on this figure, the standing stock size can be estimated about 2 million metric tons, i.e., 1.8 x 1/(0.9) = 2.0. This figure agrees well with that in Table 23.

1/ Actual opening width of the mouth of trawl net at the sea bottom during trawling is 21.7 metres, and the mean towing speed is 3.5 knots

Table 23. The densities and the sizes of the standing stocks of demersal fish in the South China Sea, the East China Sea, and the Yellow Sea

Subarea	Areas 1/ ('000 km^2)	Present Catch ('000 t)	Period of study	Standing stock Density (kg/ha)	Standing stock Size ('000 t)	Intensity of exploitation
Northern Mainland Shelf	341		1931-38 1956	29.5 16.6	1 006 566	Moderate Heavy
Gulf of Tonkin	131	900 2/	1931-38 1956	28.5 28.2	373 369	Light Light
Southern Mainland Shelf	89		1969-70	18.0	160	Light
Sub-total	561	900		19.5 4/	1 095 4/	
Northern Sunda Shelf	87		1969-70	17.5	152	Light
Central Sunda Shelf	276		1969-70	17.8	491	Light
Gulf of Thailand	304	1 308 3/	1961 1970	28.2 9.2	857 480	Light Heavy
Southern Sunda Shelf	330		1969-70	11.7	386	Light
Eastern Sunda Shelf	232		1969-70	25.4	589	Very light
Karimata-Gasper Region	151		1969-70	8.9	134	Very light
Sub-total	1 380	1 308		14.7 4/	2 032 4/	
Total	1 941	2 158		16.1 4/	3 127 4/	
East China and Yellow Seas	1 045	1 800	1950 1930	18.3 50.4	1 913 5 266	Heavy Light

1/ Waters under 500 metres depth (area is about that under 200 metres 1.1)

2/ Present catches of Mainland China, 500; Taiwan, 180; Hong Kong, 71; and North Vietnam, 100 to 200 (in '000 metric tons)

3/ South Vietnam, 237; Cambodia, 30; Thailand, 900; Malaysia, 130; Singapore, 11; Indonesia, very few. Philippines, 50 is not included in this table because of the lack of estimation on stock density of Luzon-Palawan Region (in '000 metric tons)

4/ In the case of two different period, the more recent data were used

4.6 Potential harvest

The potential harvest, i.e.,the sustained catch that can be taken year after year under the correct exploitation rates, must be closely related to the standing stock. However, it is unlikely that there is a constant proportional relationship between the potential harvest and the unexploited standing stock. Short-lived species, with a high turnover rate, can withstand a higher rate of exploitation than long-lived species. It is probable that stocks of small fish and stocks in warm water will have a higher turnover rate than stocks of larger species, or stocks in cold water. The optimum rate of exploitation in the South China Sea is therefore likely to be higher than that in the East China Sea or Yellow Sea.

Another important question relating to harvesting strategy is the extent to which the standing stock is reduced from its maximum unfished level, when the optimum harvest is being taken. The precise value will vary according to the biological characteristics of the stocks concerned, and also on the criterion adopted in determining the optimum harvesting strategy (maximum sustained yield in weight, maximum economic yield, etc.). A moderately conservative value might be half the unexploited standing stock. If the current standing stock is greater than this, the rate of exploitation can probably be increased, whereas if the stock is less then the stock may be being overexploited, and should be carefully assessed before allowing any increased fishing.

Table 24 sets out the standing stocks in each area at this optimum level, at the maximum level, and, for comparison, the present standing stocks. In computing the first two, it was assumed that the present standing stocks in the areas noted in Table 23 as very lightly exploited are equal to the maximum standing stock. The abundance of lightly exploited stocks (e.g.,Gulf of Thailand in 1960) was taken as 90 percent of the maximum, and that with moderate exploitation (e.g. Northern Mainland Shelf in 1931-38) as 80 percent of the maximum.

Also included in the table are rough estimates of the optimum harvesting rate, and the potential yield that can be taken. It must be emphasised that these figures are, in the absence of better information, only approximate. They are included firstly, as a rough order of magnitude,as a guide to the probable yields that can be taken from each area and secondly, as an illustration of the calculations that may be used to obtain better estimates when improved data are available.

Some confirmation of the reasonableness of the values used is given by independent assessments of the East China Sea and the Gulf of Thailand. Both these are now heavily exploited, and standing stock and (to a lower extent) total catch are probably below the optimum. The present catch taken in the Gulf of Thailand is not known exactly, because some of the 900 000 tons taken by Thailand comes from outside the Gulf. It is probably around the 700 000 tons given as the potential sustained catch in Table 24.

Regarding individual areas, the following comments may be made:

(1) Northern Mainland Shelf

The present stock size of 556 000 metric tons is close to the optimum stock size. This may indicate that the present fishing intensity has approached the level of rational utilisation of the demersal fish resources in this subarea. The fishing mortality coefficient $\underline{F}$ of this stock is roughly estimated as 1.0.

These waters were exploited extensively by the Japanese trawlers during the pre-war years; finally they stopped their operations until 1960. It is believed that the fishery stopped because the catch rate declined. At present, aside from the Japanese trawlers, many trawlers and longliners from Taiwan, Hong Kong, and possibly from Mainland China are operating in this subarea. As mentioned previously, the main fishing grounds of Taiwan's trawlers have progressively moved toward the southwestern waters. This fact may also indicate the decline in the abundance of the fish in these waters. The necessity of decreasing fishing intensity in these waters has already been pointed out by the Hong Kong Fisheries Research Station (see Section 3.2.3).

Table 24. Standing stock and catches ('000 tons)

	From Surveys	At Maximum	At Optimum	Assumed Optimum Harvesting Rate	Potential Catch	Present Catch
East China and Yellow Seas	1 913 (1950) 5 266 (1930)	5 852	2 926	(0.6)	(1 755)	1 800
Northern Mainland Shelf	566 (1956) 1 006 (1931-38)	1 257	560		560	
Gulf of Tonkin	369	410	205	(1.0)	205	900
Southern Mainland Shelf	160	178	89		89	
Sub-total					854	
Northern Sunda Shelf	152	152	76		114	
Central Sunda Shelf	491	491	245		367	
Gulf of Thailand	857 (1960) 280 (1971)		952	476	(1.5)	714	1 308
Southern Sunda Shelf	386	386	193		290	
Eastern Sunda Shelf	589	589	295		442	
Karimata-Gasper	134	134	77		115	
Sub-total					2 042	
Total					4 946	4 108

(2) Gulf of Tonkin

According to the preliminary calculation indicated in this report the present stock size of 369 000 metric tons is considerably larger than the optimum level. This situation clearly indicates that more fishing operations can be carried out in the Gulf. As described previously, Japanese trawlers have fished for a short period in the Gulf. It is believed that the demersal fish stock in these waters has not changed much during the past two decades, but there is a lack of detailed information on fishing activities in this Gulf.

(3) Gulf of Thailand

The present size of the standing stock is well below the optimum level according to the rough guideline used here. As described before, the abundance of demersal fish in the Gulf has declined markedly, and many authors have already pointed out that the fishing intensity has exceeded the M.S.Y. level since 1966-67. It is suggested that suitable management measures for the conservation of the demersal fish stock in the Gulf should be taken without delay.

(4) The demersal fish stocks in many other subareas of the South China Sea seem to be nearly virgin, except in the very shallow coastal waters. Hence, further expansion of fishing intensity in these areas may be possible, and fair amounts of catch can be expected from these subareas.

(5) Concerning the Mainland Shelf, the total standing stock size is almost the same as the potential. Further increase in fishing intensity is not suitable, since there is a possibility of overfishing, although taking the region as a whole, there are opportunities for careful expansion in certain areas.

(6) Regarding the Sunda Shelf, except the Gulf of Thailand, further expansion of trawling activities is possible. However, it is suggested that the introduction of more fishing vessels into these waters should be carefully planned.

5. SOME COMMENTS ON DEMERSAL FISH STOCKS AND FISHERIES IN THE SOUTH CHINA SEA

5.1 Geographical distribution

As shown in Figures 5 and 6 the geographical distribution of the demersal fishes in the South China Sea, as compared with that in the temperate zone such as the East China Sea and Yellow Sea, has the following characteristics: high density areas or richer waters are very close to the coasts and the fish density in the central part of the continental shelf is, in general, less or sometimes low. According to a more detailed study on seasonal changes in the geographical distribution, more or less high density areas are found in offshore waters or often in the central part of the Sea in summer. This distribution pattern has been observed not only in the South China Sea but also in many other tropical waters in the world.

On the contrary, demersal fishes in the waters of temperate or polar zones are more or less equally distributed all over the continental shelves, and often significant migrations of the fish can be observed. For example, in the case of the East China and the Yellow Seas, the fish concentrate in the offshore or central parts of these seas, sometimes in rather deep waters, in winter. In spring and early summer, many kinds of fishes migrate to inshore waters, sometimes very close to the coasts in order to spawn.

In the tropical or semi-tropical waters the fish have neither a winter season nor a significant spawning period. Although affected by monsoons or wet and dry seasons, the cycle of nutrients is more active in shallower waters. Accordingly, it is considered that the richer waters are located near the coastal zone in these seas.

These conditions for the demersal fishes in the South China Sea are, naturally, related to the problem of how to control and adjust the use of many kinds of demersal and pelagic trawling gear in coastal waters.

5.2 Species composition and the problem of "trash" fish

At present it is somewhat difficult to make a synoptic examination of the species composition of demersal fishes of the South China Sea as a whole because the system of both taxonomic and economic classification of the demersal fishes in the fisheries statistics and reports from research vessels are different from country to country. In general, however, the significant phenomenon as described below is found in the demersal catches from the South China Sea. It is a well known fact that the species composition in the seas of the polar zones is composed of only a few dominant species, and that in temperate zones, several major species are dominant. For example, in the East China Sea, five to six species (or groups of species) are dominant, and the sum of them accounts for about 60 percent of the total landings. Differently, the total landings in the South China Sea are composed of many kinds of fishes, and the stock size of each of them is rather small. In other words, the dominancy of single fish species in polar zones is very high; it becomes lower in temperate zones, and in tropical zones it is very low. It is interesting that this same tendency can also be seen within the South China Sea. According to a rough examination, the percentage of the most important five species (or groups of species) in the total catch on the Northern Mainland Shelf is about 50 percent; that in the Gulf of Thailand about 44; West Malaysia about 35 and that in Sarawak only 23 percent (Table 25).

The figures in this table are not very reliable since some items are composed of only a single species, while others are composed of many kinds of fishes. It is thought, however, that these figures represent the general tendency mentioned above.

The so-called "trash" fish in the demersal catches is one of the important problems in the South China Sea. The names of the major fish species are shown in Table 25, and several studies of these fishes have been made. But the trash fish which compose more than half (approximately 60 percent) of the total catch, have not been studied much. Therefore, some discussion of this problem will be given below.

"Trash" fish is not a taxonomic term but an economic one. Trash fish are composed of many species of comparatively small-sized fishes including young fish of economically important species. It is thought that there are two categories of trash fish, those having no economic value at all, and those having some economic value. The former are discarded but the latter are utilized for many purposes: as fish meal, food for ducks, etc.

The definition of "trash", naturally, varied with the advancement of the techniques for fish preservation on board the vessels and in the fish markets as well as with the processing of fishery products in the factories.

Another problem of trash fish comes from the difference in the economic evaluation of fish species. Some species are economically more important in some countries, while in other countries they are ignored. This situation exists in southeast Asian countries. A more detailed examination of the problems and exchange of information among countries is needed so that we can avoid the waste of demersal fish resources and increase the value of the landings.

6. CONCLUSION AND RECOMMENDATIONS

(1) The continental shelf in the South China Sea may be divided into two major areas: the Mainland Shelf located in the northern part and the Sunda Shelf in the southern part. According to the demersal fish stock evaluation presented in this report, it is suggested that the fishing intensity should not be increased above the present level on the Mainland Shelf as a whole, as such increase may adversely affect the productivity of the stocks in subsequent years. The fishing intensity in the waters from Taiwan Strait to Hainan Island should be reduced because it has already surpassed the level of M.S.Y.

Table 25. The percentage of major species or groups of species[1] in the catch by different subareas[2]

Ranking number	East China and Yellow Seas (1966–70)		Northern Mainland Shelf: Japanese trawler (1956)		Northern Mainland Shelf: Hong Kong (1960–70)		Gulf of Thailand (1966–70)		West Malaysia (1970)		Sarawak (1970)	
	Species	%	Species	%	Species	%	Species	%	Species	%	Species	%
1	Hair tail	25	Yellow sea bream	24	Golden threads	20	Pony fishes	10	Shrimps	29	Shrimps	7
2	Yellow croaker	13	Lizardfishes	15	Conger pike eel	7	Horse mackerels	9	Croakers	3	Wolf fishes	5
3	Conger pike eel	9	Red sea bream	5	Lizardfishes	7	Golden threads	9	Golden threads	2	Sharks	5
4	White croaker	6	Golden threads	5	Scads	6	Squids	8	Catfishes	1	Rays	3
5	Lizardfishes	5	White croaker	5	Bigeyes	5	Bigeyes	8	Goatfishes	1	Queenfishes	3
Total		58		54		45		44		35		23

1/ Scientific names: Hair tail, *Trichurus lepturus*; yellow croaker, *Pseudosciaena polyactis*; conger pike eel, *Muraenesox cinereus*; white croaker, *Nibea argentata*; lizardfishes, *Saurida* spp.; yellow sea bream, *Taius tumifronts*; red sea bream, *Argyrops cardinalis*; golden threads, *Nemipterus* spp.; scads, *Decapterus* spp.; bigeyes, *Priacanthus* spp.; pony fishes, Leiognathidae; horse mackerels, Carangidae; squids, *Loligo* spp.; croakers, Sciaenidae; catfishes, Tachysuridae; goatfishes, *Upeneus* spp.; wolf fishes, Chirocentridae; queenfishes, *Chorinemus* spp.

2/ Source: Trawl statistics from research vessels or commercial fleets, except Sarawak which includes landings by many types of coastal gear

(2) For the Sunda Shelf as a whole, it is believed that the demersal fish stocks are still remaining more or less in a virgin state, except those in the Gulf of Thailand and in the inshore waters off South Vietnam. Hence, further development of trawl fishery in these waters may be possible. Nevertheless, the development of demersal fisheries in these waters should be carefully planned as several ecological and economic problems pertaining to the development of demersal fisheries in tropical or semi-tropical waters remain to be solved.

(3) In the Gulf of Thailand, due to the rapid expansion of the Thai trawl fishery, the present fishing intensity has already exceeded the level of M.S.Y. Therefore, measures to reduced the fishing intensity in the Gulf are needed urgently.

(4) Monitoring surveys on the demersal fish stocks which are subject to increased fishing activities in the South China Sea are very essential. They could be carried out through regional cooperative efforts. Furthermore, regional consultations on the state of the resources and management measures on a regular basis should be arranged.

(5) Several unknown factors related to the fishery biology and taxonomy of demersal fish species of the South China Sea are prevalent. Further studies are needed in order to achieve the objective of rational utilization of these resources.

(6) Fishery is considered one of the economic activities pursued by countries bordering the South China Sea. Therefore, the problems pertaining to the utilization of the demersal fish resources in these waters are not only in the realm of natural science but involve the consideration of both social and economic aspects. It is recommended that studies from the viewpoint of utilization of the catches and of fishing enterprises be carried out in parallel with those on fishery biology and stock assessment. From various sources of information mentioned above, effective fishery development planning could be made.

(7) The area coverage for the survey of the demersal fish resources and fisheries in the South China Sea should be expanded. Additional surveys should be carried out in the waters off the west coast of the Malay Peninsula, the Strait of Malacca, in the Indonesian waters and in the inter-island waters of the Philippines. It is believed that further demersal fishery development in these waters may be possible.

(8) Some countries in the South China Sea region have already initiated experimental and exploratory fishing using modern bottom longline or vertical line. This type of fishing gear is very useful in many untrawlable areas of the South China Sea such as many banks and reefs, particularly the waters with rough bottom off the northern coast of Borneo and Palawan Islands. According to preliminary results, most of the demersal fish stocks on these untrawlable grounds are still in a virgin state.

(9) The consideration of demersal fisheries in coastal waters is omitted in this report because of the shortage of time though there is information available. It is recommended that studies be carried out on the problems pertaining to demersal fisheries in the coastal waters since these are areas of high stock density in the tropics.

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